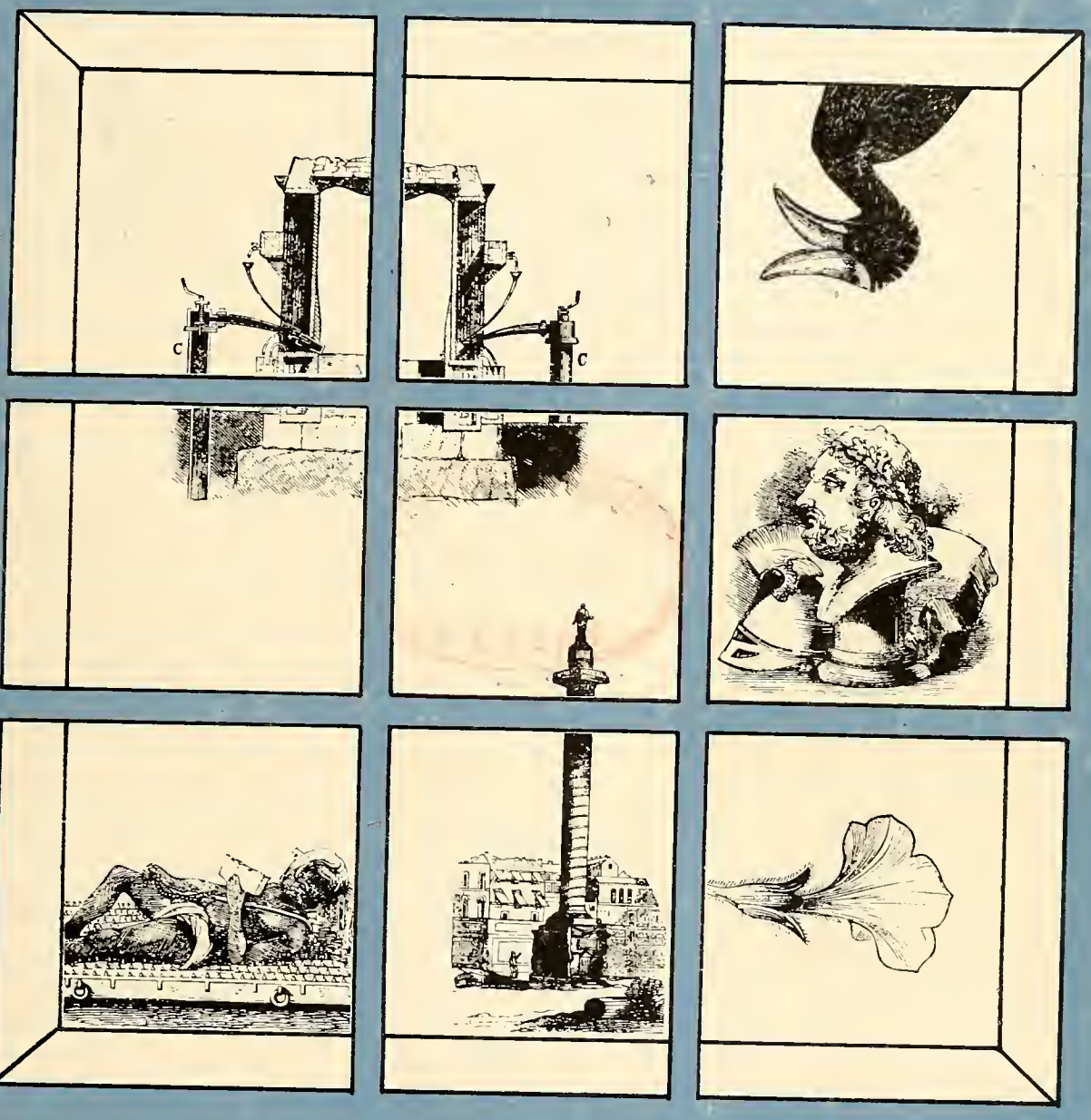
LEHIGH

MARCH, 1977



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LEHIGH

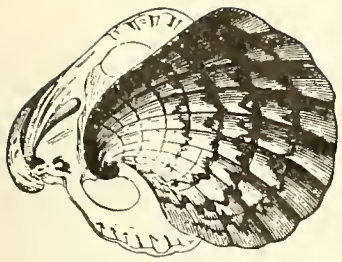

Fig 1501. — SHELL OF A LAMELLIBRANCHIATE.
(*Genus Cardium.*)

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Every effort has been made to insure the accuracy, consistency and completeness of material in this edition. However, the editors have not subscribed to the philosophy expressed by Thomas Jefferson in a letter to Washington, "Delay is preferable to error"; rather, there has been a need to meet a deadline and an acknowledgement that *errare humanum est.* Rather than apologize, the editors of *Lehigh* refer the reader to a boast made by the editors of the 1771 edition of *Encyclopaedia Britannica*: "With regard to errors in general, either falling under the denomination of mental, typographical, or accidental, we are conscious of being able to point out a greater number than any critic whatever."

Illustrations which appear on the covers and inside this edition are from "Zell's Popular Encyclopedia, a Universal Dictionary of English Language, Science, Literature and Art," printed by T. Ellwood Zell, Philadelphia, 1870. The volume is available in the university's Linderman Library.

PRESIDENT STATES LEHIGH PHILOSOPHY

Dr. Deming Lewis has been president of Lehigh University since 1965. During that period the university has made significant innovations in its educational programs, bolstering its traditional strength in undergraduate education and developing the size and scope of its Graduate School.

Before coming to Lehigh, Dr. Lewis was a distinguished leader in the nation's space and communications programs. As a space engineer and research administrator, Dr. Lewis was one of four Bell System executives who in 1962 initiated the work of Bellcom, Inc., in Washington, D.C. Bellcomm engineered systems for the Apollo space program which placed the first man on the moon. The university president holds thirty-three patents.

Dr. Lewis entered Harvard University at the age of sixteen and earned the bachelor of arts and master of arts degrees in mathematics. Thereafter he was a Rhodes scholar in advanced mathematics, earning two degrees from Oxford University in England. Subsequently, Dr. Lewis earned the doctor of philosophy degree at Harvard. A number of colleges and universities have awarded him honorary degrees, including four doctor of laws degrees, the doctor of engineering, the doctor of science, and the doctor of humane letters.

The president's comments follow.

Fig. 591. — KNIGHT'S COSTUME (1272). (From the Library of MSS. at Paris.)

"One of the pleasures of being president of a university is the opportunity to introduce students to the exciting and challenging world of the intellect that Lehigh can offer. There is so much to tell you about Lehigh that the most difficult task is determining not what to include, but rather what can be left out. These decisions are left to those who edit our publications; however, I do want to welcome you if you are unfamiliar with Lehigh and to encourage you toward success if you are a Lehigh student already.

"Lehigh University seems to me to be one of the most vigorous institutions in higher education in the nation today. We are moving forward dramatically in many areas of endeavor. The consequence is that Lehigh has become, among its peer institutions, a university deemed worth watching. This recognition has not come by accident; everything that happens at Lehigh results because of a deliberate plan.

"When I was inaugurated as president on October 10, 1965, I expressed in my address the following view of the university in society:

" 'On the one hand a university must preserve and understand the intellectual treasures of the past. On the other hand it must encourage the questioning of conventional wisdom in order that greater wisdom can be found. On the one hand its stock in trade is activities of mind and spirit. On the other these mental and spiritual activities can flourish only within a stable and healthy framework of faculty salaries, student life, auxiliary services and physical plant.'

"These remarks come to mind because it occurs to me that they in some measure reflect the 'Lehigh philosophy', namely the idealistic in combination with the pragmatic. When Asa Packer founded this great university in 1865, the intention was to combine the practical technical education then offered in Germany with the traditional arts education offered in the British universities. This was a classic example of bringing together the idealistic and the practical for the greater good of Lehigh students and society. Since then generations of graduates have proven that the founder's dual approach was intrinsically sound. More than a century later, our allegiance to the founder's goals remains unaltered.

"There is a key word that underlies any success this university has achieved. That word is 'planning.' Our progress during the past years is the direct result of our planning—planning undertaken with the advice and consent of our alumni, faculty, students and parents. At Lehigh we believe that it is exciting and challenging to have well-conceived plans to work toward, and there is no greater pleasure than seeing the plans come to fruition.

"It is my sincere hope that the information which follows fits together in a way that will help you to perceive Lehigh University as an institution which continues to achieve excellence, and that you will find programs stimulating and appropriate for implementing your personal goals.

"The Lehigh philosophy is so direct and simple that it may sound unsophisticated. Through exposure in the major area of interest, the student is required to develop a considerable degree of expertise in the chosen field. This is combined with subject requirements covering a spectrum of subjects in a meaningful way at a minimum level. Thus the Lehigh tradition of graduates who are experts in their field and who also contribute to their families and society in another important way because of their wider knowledge and understanding of social responsibility. Even in the area of engineering, where there are more 'nuts and bolts' types of courses, this philosophy remains valid. John J. Karakash, dean of the College of Engineering and Physical Sciences, expresses this as follows: 'Lehigh does not train engineers; it educates students through engineering.'

"The distinguished scholar and government official, John W. Gardner, wrote the following paragraph in his book *Excellence*:

Colleges. . .must equip the individual for the never-ending process of learning; they must gird his mind and spirit for the constant reshaping and reexamination of himself. They cannot content themselves with the time-honored process of stuffing students like sausages or even the possibly more acceptable process of training them like seals. It is the sacred obligation of the schools and colleges to instill in their students the attitudes toward growth and learning and creativity which will in turn shape the society.

"We wholeheartedly agree. Lehigh accepts responsibility for planning its programs in a way that will make possible the graduation of fine men and women who are a credit to

themselves and their alma mater and who are also moving forces in the betterment of their communities and society."

DR. W. ROSS YATES: HOW MASTER PLAN WAS CONCEIVED

The author of the brief university history which follows, Dr. W. Ross Yates, holds the bachelor of arts and master of arts degrees from the University of Oregon, in his native state. He also received the doctor of philosophy degree from Yale University and studied in France on a Fulbright Scholarship.

Dr. Yates joined the Lehigh staff in 1955 and served as dean of the College of Arts and Science from 1963 to 1972. Today he is a professor of government.

Dr. Yates has written a history of the Lehigh Valley region and served as general editor of two volumes concerning the history of Bethlehem. He and James D. Mack, curator of rare books, have been planning a full-fledged history of the university.

By Dr. W. Ross Yates

When the sound of the last cannon of the Civil War had died away, the statesmen, educators, and industrial pioneers marshalled the victorious forces of the North and turned their attention to education.

They sought to open a new chapter in the development of the Union by increasing the number of scientists, engineers, and other skilled people who could transform the vast natural resources of the country into a strong and independent national economy.

Asa Packer was one of the industrial pioneers. He had built the Lehigh Valley Railroad and controlled a coal-mining empire in the mountains of eastern Pennsylvania. He knew, as did many others, that a strong national economy depended on more than technical skills. It needed above all people broadly educated in the liberal arts and sciences—people who could combine practical skills with informed judgments and strong moral self-discipline. He kept this in mind in founding and endowing Lehigh University.

The Bishop's Account

The site which Packer chose for his university was a railroad junction across the Lehigh River from Bethlehem, the community founded in 1741 by Moravian missionaries. William Bacon Stevens, Episcopal bishop of the Diocese of Pennsylvania and the first president of the university's board of trustees, in 1869 described the origin of the university as follows:

"In the fall of 1864 an interview was requested of me by the Hon. ASA PACKER, of Mauch Chunk [now Jim Thorpe]. He came to my house in Philadelphia, and said that he had long contemplated doing something for the benefit of his State, and especially of the Lehigh Valley. From that valley he said he had derived much of the wealth which GOD had given to him, and to the best interests of that valley he wished to devote a portion of it in the founding of some educational institution, for the intellectual and moral improvement of the young men of that region.

"After conversing with him a little while, and drawing out his large and liberal views, I asked him how much money he purposed to set aside for this institution, when he quietly answered that he designed to give $500,000. At the time of this interview no one in this country, it is believed, had offered in a single sum such an endowment for a literary institution. It was the noblest offering which an American had ever laid on the altar of learning, and more than equaled many royal donations which have carried down the names of kings as patrons of European universities.

"Filled with profound emotions at the mention of such a gift for such an object, I asked the noble donor what specific plans he had framed in his own mind in reference to it. His reply was, 'I am not much acquainted with these matters, but you are, and I want you if you will to devise a plan which I can put into effective operation.' I told him that I would make the attempt. I did so. I drew up the outline sketch of such an institution as I thought would give the largest results for the means used, and submitted it in a few weeks to his inspection.

"He examined it with the practical judgment and business habits with which he deals with all great questions, and adopted the scheme as the basis of his future university.

"The first meeting of the Board of Trustees, selected by JUDGE PACKER, met at the 'Sun Hotel,' in Bethlehem, July 27th, 1865, and began to organize the work before them."

The Early Years

The trustees followed several principles in setting up the university. One was that of combining scientific and classical education. They considered both to be practical. As Bishop Stevens pointed out, the principle carried forward an ideal of the great 17th-century Moravian educator, John Amos Comenius. A motto taken from the works of Francis Bacon was used to summarize this principle, namely, *Homo minister et interpres naturae*—man, the servant and interpreter of nature, to use a free translation. This motto appears today in the university seal.

The first five schools of the university included a School of General Literature in addition to four scientific schools of, respectively, civil engineering, mechanical engineering, mining and metallurgy, and analytical chemistry. The trustees sought as first president a man whose education and habits expressed this principle, ending their search by choosing Henry Coppee.

Another principle upon which the trustees insisted was that of keeping the size of the student body proportionate to the abilities of the faculty to teach them well. The university would admit only as many freshmen each year as it could be assured of providing with the highest quality of education. In the 19th century the total enrollment never exceeded

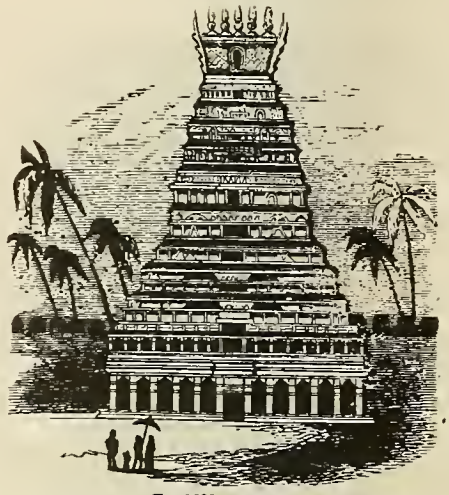

Fig. 1288.—GOPURA,
(or gate leading into the inclosure of the temple at Seringham.)

several hundred students, although the size increased with the endowment and the number of faculty.

The trustees also insisted that Lehigh was to be nondenominational and would have an admission policy based on merit. Competitive examinations were held for applicants for admission. From 1871 to 1891 no tuition was charged.

At first the student body was entirely male. The ideological climate of the 19th century would permit nothing else. But, several decades after the establishment of graduate studies, around 1916, women were admitted to graduate programs. When by 1971 the climate of opinion had reversed itself on the question of educating women in practical scientific and engineering work, the university opened its undergraduate program to them as well as to men.

Flannel Shirts

From the first, the students were seriously minded. In 1924 Catherine Drinker Bowen, daughter of president Henry S. Drinker and later a famous biographer, published a brief *History of Lehigh University*, in which she commented:

"Ask any college professor which brand of boy he would prefer to teach, the cigarette brand or the flannel shirt variety. Right here we offer ten to one the flannel shirts. . .Lehigh still holds to the emblem of the flannel shirt—long may it wave! Engineers come to college to work. A writer in the *Syracuse Post* in 1895 spoke truthfully when he said, 'From the first, Lehigh's characteristic has been her earnestness. It is the boast of her graduates, the inspiration of her students. Men go there to learn to take a useful part in the economy of life'."

The students' ambition and zeal bore fruit; as alumni they carried the university's educational goals into the work of nation-building. And, having received, they gave to perpetuate Lehigh's work of service. The university community was constantly infused with new faculty and students determined to renew and rework the original principles in the light of changing times.

Today, Lehigh University still adheres to Asa Packer's goal of a liberal and scientific education for practical service. Faculty and students work to maintain quality. Faculty and administration seek income from individuals, foundations and government so that quality is retained while tuition is kept as low as possible. Present levels of tuition cover only about half the cost of a Lehigh education.

Tuition, under the conditions of the 20th-century economy, is unhappily with us. But it is not necessarily an evil. It becomes such in the measure that it tends to assign a dollar value to education. Packer knew that many could not comprehend the intrinsic value of the "practical and scientific education" which he desired. Tuition is somewhat more palatable when viewed as a contribution to the cause of education, which ultimately supports a way of life which Americans hold dear.

Lehigh is still a small university, lacking the enormous student bodies and the plethora of professional schools which characterize its larger cousins. At the beginning of 1977, Lehigh had approximately 4,000 undergraduates and 2,200 students enrolled in graduate programs. About eight-hundred of the undergraduates were women, with the likelihood that the proportion of women would increase in future years.

An Overview

From the handful of buildings constructed amidst "a noble park of forest trees," as Asa Packer characterized the chosen locale, Lehigh University has grown to encompass some one-hundred buildings on the original South Mountain campus and on the relatively new 478-acre Saucon Valley campus to the south.

On a clear day, Lehigh students may not see forever, but the view afforded from a number of campus buildings usually extends northward across and beyond the host city of Bethlehem to the crest of the Kittatiny mountains some twenty miles distant. Along the northern horizons are the Appalachians and the famous Appalachian trail which leads to termini in Georgia and Maine.

Lehigh alumni have gone to Georgia and Maine and far beyond, not by hiking but in a pursuit of professional excellence which has placed them across the nation and on foreign shores. Today's Lehigh men and women, fulfilling the promise expressed in the Alma Mater, "live to make their lives add lustre" to their university.

ACCREDITATION

Lehigh University is fully accredited by the Middle Atlantic States Association of Colleges and Secondary Schools.

In addition, specialized programs in business administration are accredited by the American Assembly of Collegiate Schools of Business, the engineering curricula are accredited by the Engineers Council for Professional Development, and Council for Professional Development, and various School of Education programs are accredited by the National Council for Accreditation of Teacher Education, including Commonwealth of Pennsylvania approval for certification programs.

DR. ZETTLEMOYER: "CHANGE IS WITH US BUT THE BASIC PHILOSOPHY WILL CONTINUE"

The following comment on the university's educational philosophy and objectives was made by Dr. Albert C. Zettlemoyer, who is the university's principal academic officer in his role as provost and vice president.

Dr. Zettlemoyer was graduated from Lehigh in 1936 with a bachelor of science degree and two years later earned his master of science. In 1941 he received the doctor of philosophy degree from Massachusetts Institute of Technology. He received the honorary doctor of science degree from Clarkson College in 1965 and the honorary doctor of laws from The China Academy, Taiwan, in 1974.

In addition to his academic administrative duties, Dr. Zettlemoyer continues to be active in research and lectures widely as distinguished professor of chemistry. His comments:

"When I joined the Lehigh faculty back in 1941, the philosophy then was that the university combined study in depth in one or more subject areas with a breadth of exposure involving courses in many subjects. Every Lehigh student had a mandate to fulfill requirements which virtually assured that no individual received a Lehigh degree with the mere accumulation of random educational credits.

"That philosophy was not new then. It was precisely in agreement with the intention of the founder to establish a bifurcated university: a technical institute of university rank, similar to the German "Realschule" of the 19th century, which also combined the liberal arts education then offered most notably in England. During the more than three decades since I returned to Lehigh as a teacher, there have been many changes. There has been extraordinary growth in all three colleges, in the physical facilities of the university, and in the number of students and faculty.

"In a world of change, it may seem to some that Lehigh's philosophy would be outdated as we continue into the late 1970s. Indeed, there have been those who would have opted for a more pragmatic approach, wherein Lehigh students would be prepared to be bold leaders of industry without the need to trouble themselves with bothersome courses in the humanities; wherein students in the arts or business would be trained within the narrow confines of their chosen fields of study.

"There have been changes of note, fine ones. The introduction of undergraduate women in 1971 has proved to be an excellent decision in which the university moves forward to better serve society in an era of new awareness and perceptions. The establishment of the Forum during that same era has made

possible faculty and student involvement in the university decision-making process. Within the past year, Dr. Nan Van Gieson became assistant provost, placing her in the highest position ever held by a woman at Lehigh. I can assure you that the new awareness of women in this formerly all-male bastion has provided for them new opportunities to contribute to education of quality, or to be its beneficiary.

"So change is with us. But there has not been a whit of change in the basic philosophy: education in depth, often in curricula which specifically prepare the student for positions in business and industry, combined with a breadth of study in many interesting fields of inquiry. I can assure you that the university will remain open to evolutionary changes during the coming decades. I can also state unequivocally that the basic philosophy of education will continue unchanged.

"The ambitious student will find in this publication innovative and interesting opportunities within each of the three colleges and transcending the customary boundaries of these entities. It is my sincere hope that our fine undergraduates and graduate students will avail themselves of these opportunities as they serve individual needs and interests, and that prospective students will clearly understand Lehigh's educational philosophy and elect to participate in what we know we do well.

"Finally, let me say that Lehigh will continue to be tough but fair academically, but above all realistic in its expectations. There is always help for those who stumble or fail, and there are options and alternative directions for those who find that their interests have shifted following matriculation. The variety of options available to Lehigh students serves to implement the human values which Lehigh holds highest.

"Remember that Lehigh believes every student it accepts should have the ability to complete the chosen course of study. (That is why we can accept only one in five applicants.) Less than two percent of those who enroll fail to attain a Lehigh degree, a fact which in some measure attests to the quality of our students and the dedication and teaching ability of our faculty."

ENROLLMENT

There are approximately 4,000 undergraduates and some 2,100 studying at the graduate level. Approximate undergraduate enrollment is as follows: College of Engineering and Physical Sciences, 1,600; College of Arts and Science, 1,325; College of Business and Economics, 975; approximately 1,050 in the graduate-level School of Education, and about 350 students enrolled in graduate programs offered by each of the three colleges.

There are approximately 425 members of the faculty at Lehigh, teaching a total of 1,750 courses. Among faculty members who are tenured and to whom the university has a permanent commitment, some 85 percent hold the doctorate degree. Those with the doctorate make up 70 percent of the entire faculty.

The ratio of students to faculty at Lehigh is 14 to 1, whereas the national average is approximately sixteen students for every faculty member.

In addition to the faculty and administrative people, the university employs some 600 supportive employees. In total, there are more than 1,500 salaried employees, about 200 wage employees and others, for a total of 1,800 persons.

A FAMILY TRADITION

About ten percent of the students enrolled at Lehigh are members of families which have Lehigh alumni in preceding generations. Such students are commonly referred to as "legacies."

These students may have the benefit of special consideration in admission because their fathers, mothers or other relatives have been in previous contact with Lehigh at the undergraduate or graduate level and therefore know the university and its personnel better than others. However, favorable treatment is not given in regard to academic qualifications. The university recognizes that the acceptance of any student without appropriate qualifications would be unfortunate for both the student and Lehigh, because professors grade only on the basis of accomplishment.

The university is proud of its "legacies" because they suggest that the education provided in years past proved valuable to those who received it so that, in many cases, they recommended Lehigh to the succeeding generation.

Among members of the Class of 1980 are a notable number of men and women who are relatives of Lehigh alumni. There are twenty-one daughters of alumni, sixty-eight sons, one granddaughter and seven grandsons. In addition, there are three women and nine men whose fathers and grandfathers are alumni of Lehigh.

Two outstanding records of family association with Lehigh University are those of freshmen Elizabeth Wolle and Frederick Cromwell Moore, Jr. Miss Wolle is a fifth-generation student whose Lehigh relatives include: her brother, Christopher S. Wolle, '79; her father, Peter C. Wolle, '53; her grandfather, Aubrey B. Wolle, '21; her great-uncle, Arthur W. Horne, '34; her great-grandfather, George A. Horne, '99; her great-great-uncle, Frederick R. Horne, '07; her great-grandfather, George H. Wolle, '87; her great-great-uncle, John F. Wolle, '85; and her great-great-great-uncle, Clarence A. Wolle, a member of the first graduating class in 1869.

Mr. Moore, a fourth-generation Lehigh man, is the son of Frederick C. Moore, M.B.A. '63, and the grandson of Robert S. Bennett, '30. He is the great-grandson of John Wesley Grace, Jr., '99, and the great-great-nephew of Eugene Gifford Grace, '99, who was president of Lehigh's board of trustees for thirty-two years.

THE CAMPUSES: THE MOUNTAIN AND A VALLEY

The university is situated on the north slope of South Mountain overlooking Bethlehem, Pennsylvania. The Saucon Valley campus is located just south of South Mountain. The main campus encompasses approximately two-hundred acres while there are 478 acres in the Saucon Valley.

While the upper portion of the campus remains in woodland, the area where classrooms are located is a kind of arboretum, with rare trees in abundance. In the spring, the magnolias planted by the university's sixth president, Henry S. Drinker, blossom. He was a leading ecologist.

Some of the trees predate the founding of the university. Others, such as the blue-flowering Chinese tree of heaven, are delicate newcomers. There are catulpas, cypresses, white birches, and massive English beeches as well as species more typically indigenous to the Middle Atlantic region. Of special interest is the Hutchinson collection of English boxwoods which graces the Alumni Memorial Building walkway.

Sayre Park, the wooded refuge which rises to the top of the mountain, is the setting for many living groups. The residences are reached via winding private roads.

The Sayre Park area is considered to be one of the most beautiful collegiate residential areas in the world, with a variety of contemporary and traditional student dwellings located in a kind of neighborhood of the young nestled into the mountainous, wooded site. All residence units on the campus afford for students a remarkable view of the entire Lehigh Valley. It can be said that, like the show tune, "on a clear day you can see forever." The foothills of the Poconos are routinely visible to students across the expanse of valley.

Because of the unique setting, some interesting architectural treatments are possible. Several dwellings are entered from upper levels, and at least one is entered from the third floor, with the living room located on the fourth level. One dwelling has a small pond formed by a mountain stream at its backdoor. The advantage of beauty in this environment is partially offset by the fact that parking places are in relatively short supply, and the creation of additional spaces is difficult and costly because of the terrain.

A substantial portion of the upper level of the campus is maintained as a nature preserve, where aesthetic students find quietude for studying outdoors when the weather is warm. The preserve includes flora indigenous to the area and wild animals in their natural habitat, including deer, squirrels, chipmunks, raccoons, and a variety of birds to please any ornithologist.

Students of geology literally have field days on the campus. They might professionally describe the campus as located in the folded Appalachians, within a few miles of the Pocono Plateau, the Triassic Newark basin, the Crystalline Piedmont, the Atlantic Coastal Plain, and the Delaware Estuary. The area is rich in deposits of coal, zinc, iron and titanium.

Besides its Bethlehem campuses, the university also operates The Wetlands Institute, located on a thirty-four acre site adjoining a coastal salt march near Stone Harbor, N.J. The institute has several laboratories and dormitory space for students. The institute is concerned with the effect of pollution on marine life, and in general with the preservation and improvement of the coastal environment. Many undergraduates undertake study at the institute.

When Asa Packer set out to found the university over a century ago, he described the site for the campus as being "in the midst of a noble park of forest trees." If the founder were to see Lehigh today, he would find the "forest trees" he loved so well evident in abundance.

The board of trustees and university officers have established and enforce policies designed to preserve the natural beauty of the campus. It is their contention that the environment in which the young adult college student pursues knowledge can make the total educational experience more meaningful, and that the ideal university environment is separate and unique from the distractions of the community.

RESEARCH EFFORT SWINGS UPWARD

Lehigh continues to gain strength as an important research institution.

Total research support exceeded $6 million for the first time in the 1975-76 fiscal year, ending June 30, 1976. For the year support reached $6,514,000, an increase of fourteen percent over the previous year. Contracts and grants accounted for $4,957,000, up eleven percent, with the remainder involving support for equipment, fellowships, and so forth.

Federal agency support rose twenty-six percent, industry and foundation funds rose nineteen percent, and state and local agencies provided an additional nineteen percent.

Particularly significant was an increase in graduate fellowship support to $95,000, up seventy-six percent, thus reversing a decline over several years.

Distribution of contract and grant support came from four principal sources: National Science Foundation, twenty-nine percent; other federal sources, forty-one percent; industry and foundations, eighteen percent; and state and local government, twelve percent.

In recent years faculty members developed an average of 260 proposals annually of which forty-seven percent were funded. The most rapidly expanding research activity during 1975-76 was in energy. Twenty-seven projects involving twenty-two faculty members representing all three colleges were under way. Projects involve environmental control of fuel combustion products; processing of coal; fluidized bed combustion; materials behavior in nuclear and coal gasification reactors; energy storage; offshore drilling structures; heat transfer, and an econometric model related to electric utility systems.

In June, 1976, the National Science Foundation selected Lehigh as one of eighteen universities to be funded through the Research Initiation and Support (RIAS) program. The grant is for three years in the amount of $218,400.

In chemical engineering, research involving mathematical modeling and simulation using the computer attracted $53,000 from the Exxon Foundation, $349,000 from the Energy Research and Development Administration for a three-year program designed to model a coal gasification plant; and $47,600 from Pennsylvania Power and Light Co. for an energy model pertaining to an electric utility. This research involved faculty from chemical and mechanical engineering as well as economics.

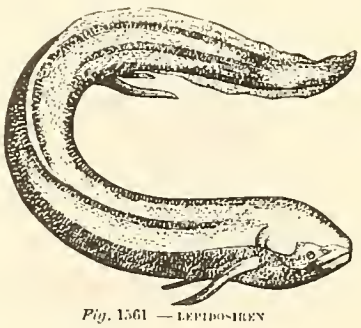

Fig. 1561 — LEPIDOSIREN

NEW CENTURY FUND TOPS $30 MILLION GOAL

Lehigh University is nationally recognized for the high level of support provided by alumni. The university completed the first phase of its $67 million New Century Fund capital campaign during 1976, exceeding the $30 million goal by more than $1 million.

Funds received through the capital campaign and the Annual Fund provide student scholarship assistance, endowed chairs through which faculty of extraordinary quality are retained and attracted, and construction of new buildings and renovation of existing structures. Such funds do what tuition alone cannot. Tuition covers only about half the actual dollar cost of a Lehigh education, not including the cost of buildings which customarily are constructed with funds obtained through gifts to the university.

The capital campaign was launched in April, 1972. The $30 million goal was exceeded by more than $1 million three weeks before the June 30 concluding date. Commitments finally reached $31.3 million.

Harold S. Mohler, '48, president of the board of trustees, said that the fund "is the most successful and the largest undertaking of its kind in Lehigh's history." Mohler is chairman of Hershey Foods Corporation.

Physical results of the campaign include the $7 million chemistry complex, which consists of the Seeley G. Mudd Building, a seven-level edifice, and an adjoining building containing three large classroom-auditoriums. This com-

Fig. 98.—AMANTHUS POLYGAMUS.

plex encompasses nearly 100,000 square feet. It is among the most advanced chemistry teaching facilities in the Northeast.

Major contribution to this project was from the Seeley G. Mudd Fund, of Los Angeles.

In the classroom building, the lobby was provided by the Pew Memorial Trust. The 300-seat Kravis Auditorium was contributed by Raymond F. Kravis, '24, of Tulsa, Oklahoma, who is chairman of Raymond F. Kravis Associates, a petroleum geology firm. The 120-seat auditorium was made possible by a gift from the Ford Motor Company Fund. The Iacocca Auditorium was the gift of Lee A. Iacocca, '45, of Bloomfield Hills, Mich., who is president of Ford Motor Company and serves on the university's board of trustees. The auditorium honors the memory of Nicola Iacocca, father of the automotive executive.

The $1.86 million Sherman Fairchild Laboratory for Solid State Studies was the gift of the Sherman Fairchild Foundation, of Greenwich, Conn.

The $1.8 million field house for intramural and intercollegiate athletics provides a new dimension for the university athletic program. Its offers 62,000 square feet of uninterrupted floor space.

Almost half the money realized in the first phase of the campaign, more than $14 million, is being directed to the permanent endowment to fund professorships, fellowships and scholarships. Additional funds will be used for the acquisition of instructional equipment and renovation of academic buildings, including Packard Laboratory.

Lehigh received $7,429,153 in gifts during the fiscal year ending June 30, making 1975-76 the best year for contributions in the university's history.

Gifts from more than 10,000 alumni, parents, friends, foundations and corporations surpassed the previous record of $6,977,583 set in 1974-75.

In a time (since 1972-73) when alumni contributions on a national level have shown a steady decline, Lehigh alumni contributions, in spite of the less than favorable economic conditions, have run counter to that trend. Contributions have grown from $1,847,285 in 1972-73 to $3,476,286 in 1975-76.

This record placed Lehigh in the top three percent or twenty-sixth among 876 institutions reporting to the Council for Financial Aid to Education during 1975. All but three of the schools ahead of Lehigh have larger alumni groups.

The 1975-76 Annual Fund raised $905,556, about $155,000 or twenty-one percent more than the $750,000 goal. Some 4,600 contributions were received from alumni, an eleven percent increase. When accompanied with the 1974-75 effort it amounts to a forty-six percent increase in alumni participation in a two-year period.

Of the total, $444,051 was received from alumni, a nine percent increase over the previous year.

The Parents Fund reached $49,832 from a record-breaking 465 parents. An additional $20,622 was donated by parents through long-term commitments to the New Century Fund.

The university is extremely proud of the financial commitments made by members of recent graduating classes through the class gift program. Those who participate in the program agree to make a contribution in a specified amount every year for twenty years. At the end of the period the class gives the money to Lehigh with instructions as to how it should be spent.

The class of 1976 established a Lehigh class gift record with 501 seniors participating in the plan, which will yield $249,500. That surpassed the previous record, held by the 1975 graduating class, which had 457 participants for a total of $228,000 upon maturity.

Lehigh takes special pride in these commitments because it knows that its students are the people best able to decide whether the university merits support. Lehigh's recent graduates have through their actions clearly indicated their support of Lehigh and its programs.

CAMPUS BUILDINGS: HOW THEY GOT THEIR NAMES

During the past dozen years, the university has constructed about thirty new residential and academic buildings with an aggregate cost of approximately $40 million. These structures provide more than one million square feet of space. The university now has more than one-hundred buildings.

Most recent of the structures are the Sherman Fairchild Laboratory (1976), the chemistry complex (1975), and the fieldhouse (1975). Residential facilities are described later in this section.

Two of the earliest buildings are known for their unique Railroad Gothic architecture. The prime example is the University Center, hub of student activities. A railroad was constructed to the site to transport the thousands of tons of stones required during construction. The other example of this colorful architecture is the President's House, located midway between the Alumni Memorial Building and the University Center.

Campus landmarks

The University Center (1868), originally known as Packer Hall. When construction began in 1865, a railroad was built to transport stone to the site. The building was extensively renovated and enlarged in 1959, but the Railroad Gothic exterior was retained.

President's House (1869). This is the home of university president Dr. Deming Lewis and Mrs. Lewis. Visiting dignitaries are entertained at the residence.

Packer Memorial Church (1887). The church was the gift of Mary Packer Cummings in memory of her father, university founder Asa Packer.

Alumni Memorial Building (1922). This Gothic edifice, housing administrative offices, is a memorial to those who served in World War I. The Ralph L. Wilson gallery is named in honor of the noted alumnus and art collector.

Linderman Library (1877). The rotunda was built by founder Asa Packer as a memorial to his daughter, Lucy Packer Linderman. The Gothic facade was added in 1929. The building houses 535,000 volumes and the rare book collection.

Academic, research and athletic facilities

Chandler-Ullmann Hall (1910, 1938). These adjoining buildings formerly were individually identified as the William H. Chandler Chemistry Building and the Harry M. Ullmann Chemistry Laboratory. Chandler served as acting university president from November, 1904, to June, 1905, and taught chemistry from 1871 to 1906. Ullmann served as chairman of the chemistry department. In 1975, the chemistry department moved into the Seeley G. Mudd Building and the combined name was adopted. The fine arts and psychology departments, Marine Geotechnical Laboratory and speech and drama are located in Chandler-Ullmann.

Christmas-Saucon Hall (1865, 1872). This is the university's oldest building. When Asa Packer purchased the South Mountain campus for the university in 1865, a Moravian church was being constructed. The newly formed university took over the structure and completed it for use in recitations and as a dormitory and chapel. The name Christmas Hall was chosen in keeping with the Moravian religious tradition. In 1872, Saucon Hall was constructed a short distance to the east of Christmas Hall. The buildings were connected with the construction of a hyphen structure in 1926.

Coppee Hall (1883, 1914). The building was originally a gymnasium. It is named in honor of Henry Coppee, first president of the university. Today the building houses the department of modern foreign languages and literature and other units.

Coxe Laboratory (1910). Originally a mining laboratory, the structure honors the memory of Eckley B. Coxe, a pioneer mining engineer and a trustee of the university. The university dropped its mining engineering curriculum several years ago. The laboratory now houses the Materials Research Center.

Drown Hall (1908). Erected by friends and alumni as a memorial to the university's fourth president, the building honors Thomas M. Drown, president from 1895 to 1904. The building is headquarters for the College of Business and Economics. Extensive interior renovations have provided special instructional classrooms and lounges.

Field House (1975). Located on the Saucon Valley campus, this facility provides 62,000 square feet of uninterrupted space for basketball, tennis and other athletic activities. The structure cost $1.86 million, which was raised through the New Century Fund capital campaign.

Fritz Engineering Laboratory (1909, 1955). The laboratory honors the memory of John Fritz, father of the steel industry in the United States and a member of the university's original board of trustees. Mr. Fritz provided funds for the original section; a seven-story addition was built more recently and accommodates the university's testing machine, which is capable of applying a five-million-pound load to tension or compression members up to forty feet in length. The laboratory is used by the department of civil engineering. The hydraulic testing machine is the second-largest such facility in the world.

Grace Hall (1940). The building is named for its donor, the late Eugene G. Grace, who was chairman of Bethlehem Steel Corporation and president of the university's board of trustees from 1924 to 1956. The building's lower level seats about 3,200 and is used for wrestling and basketball as well as some concerts and lectures. The upper level accommodates the military science and aerospace studies departments.

Johnson Hall (1955). The building houses the university health service, the counseling service, the personnel office, the chaplain, and the motor vehicle office. The building honors the memory of Earle F. Johnson, '07, who was a director of General Motors. Mr. Johnson made a major contribution toward the structure. The gift was made anonymously, but during 1976 the university obtained permission from Mr. Johnson's family to name the building in his memory.

Lamberton Hall (1941). The structure originally served as the university commons. Food was served to students in the building until the renovation of the University Center was completed during the latter 1950s. The building honors the memory of Robert A. Lamberton, third president of the university, who served from 1880 to 1893. Today the structure houses the music department.

Maginnes Hall (1970). The contemporary multilevel structure is headquarters for the College of Arts and Science and also houses the departments of English, history, government, international relations, classics, and religion. The university bookstore is located on the ground floor. The building is named for Albert B. Maginnes, '21, a lawyer and trustee of the university from 1954 to 1966. Mr. Maginnes was the father of Mrs. Henry Kissinger, wife of the former secretary of state.

Mart Science and Engineering Library (1968). This contemporary structure honors the memory of Leon T. Mart, '13, and his son, Thomas, '51. The library houses more than 100,000 volumes in the fields of engineering, mathematics, and natural and physical sciences.

Philosophy Building. This small structure near Packer Memorial Church served for many years as the chaplain's residence. Today it is the home of the philosophy department. The year of construction is not known.

Packard Laboratory (1929). The structure was the gift of inventor James Ward Packard, '84, the automotive and electrical pioneer. The first Packard automobile (1899) is housed in the lobby. The building is the headquarters for the College of Engineering and Physical Sciences and also houses the classrooms and laboratories for the departments of electrical and industrial engineering, and mechanical engineering and mechanics.

Physics Building (1892). This massive five-story stone structure (240 feet long) was extensively renovated in 1960-61. It contains laboratories and teaching facilities for undergraduates and graduate students in the field of physics.

Price Hall. This structure formerly was a brewery named "Die Alte Brauerei." In 1912 it was remodeled to serve as a dormitory, and it was named in honor of Henry Reese Price, a former president of the university board of trustees. Today the building serves as the home of the social relations department.

Rathbone Hall (1971). This student dining facility, with its window walls affording a superb view of the Lehigh Valley, honors the late Monroe Jackson Rathbone, '21, president of the university board of trustees for sixteen years. Mr. Rathbone was chairman of the board, Standard Oil Co. (New Jersey) and was a major innovator in the oil industry. He died in 1976. The lower level of Rathbone Hall houses the residence operations offices.

Seeley G. Mudd Chemistry Building (1975). This seven-story tower provides a fine home for the chemistry department and its students on both the undergraduate and graduate levels. The tower is part of the $7 million chemistry complex, which also includes an adjoining structure housing three large classroom-auditoriums. The late Dr. Mudd was a California medical doctor. The Seeley G. Mudd Foundation, of Los Angeles, made a major gift toward the building.

Sherman Fairchild Laboratory (1976). This $1.9 million research facility provides new space and equipment for solid-state study. It was the gift of the Sherman Fairchild Foundation, of Greenwich, Connecticut. The late Mr. Fairchild was an iconoclastic inventor who made significant contributions in a variety of fields. He was the son of the founder of IBM.

Sinclair Laboratory (1970). This contemporary building houses the Center for Surface and Coatings Research and the National Printing Ink Research Institute. It is named in honor of Francis MacDonald Sinclair, and was the gift of his widow, Mrs. Jennie H. Sinclair.

Taylor Gymnasium and Field House (1913). This structure was the gift of Charles L. Taylor, Class of 1876, who was a friend and business associate of steel magnate Andrew Carnegie. The structure has recently been undergoing extensive renovation. There are two indoor swimming pools, five basketball courts, a weight room and a fencing room. The structure adjoins Taylor Stadium, which seats approximately 16,000 persons.

Wilbur Powerhouse Drama Workshop (1908). During most of its life, the building served as the university's power plant. Power now is produced in a modern structure a short distance away. The old building has been extensively renovated so that it provides an open space suitable for dramatic productions by students.

Whitaker Laboratory (1965). This five-story structure with an adjoining two-level classroom-auditorium section honors the memory of Martin D. Whitaker, president of the university from 1946 to 1960. Dr. Whitaker had been director of the Atomic Energy Commission laboratory at Oak Ridge, Tennessee, before coming to the university. The buildings serve the department of metallurgy and materials science, and the chemical engineering department. There are laboratories for high pressure research and reaction kinetics, nuclear studies, analog computation, process control, high temperature thermodynamics and kinetics, and fine structures and metallography.

Williams Hall (1903). This large brick structure was the gift of the late Edward H. Williams, Jr., Class of 1875. Dr. Williams was a professor of mining and geology at Lehigh for twenty-one years. The building contains the classrooms and laboratories of the departments of biology and geological sciences. A greenhouse used by students of botany adjoins the building. Following a fire, the building was extensively renovated and a fourth story added in 1956.

In addition to the above, there are a number of smaller structures on the campus, and several larger structures located near the campus. These units serve a number of units of the university. They are not included here either because they are temporary facilities or because data is not available.

Residential facilities

Lehigh is primarily a residential university. Approximately eighty-two percent of undergraduates reside in university-owned or university-related facilities.

Some 2,100 students live in on-campus residence halls, which are listed below, and in the Saucon Married and Graduate Students apartments on the Saucon Valley campus, in the Bishopthorpe Residence located in nearby Fountain Hill, and in the university's Polk Apartments in Bethlehem. An additional 1,100 students live in thirty-one fraternity houses, twenty-seven of which are located on campus, mostly in the Sayre Park residential area.

Residence halls

Centennial I complex (1965)

Congdon House. Dr. Wray H. Congdon served as dean of students, dean of the Graduate School and special assistant to the president, retiring in 1961.

Emery House. Honors the memory of Dr. Natt M. Emery, vice president and controller, who died in 1953.

Leavitt House. Named for the Rev. Dr. John McD. Leavitt, second president of the university, who served from 1875 to 1879.

McConn House. Named in memory of Dean C. Maxwell McConn, dean of the university from 1923 to 1938.

Smiley House. Dr. E. Kenneth Smiley served as vice president from 1945 to 1964.

Thornburg House. Named for Dr. Charles G. Thornburg, professor and head of the department of mathematics, 1895 to 1923.

Centennial II complex (1965)

Beardslee House. Dr. Claude G. Beardslee was chaplain from 1931 to 1947.

Carothers House. Dr. Neil Carothers was dean of the College of Business and Economics from 1936 to 1949.

Palmer House. Dr. Philip M. Palmer was dean of the College of Arts and Science from 1936 to 1950.

Stevens House. The Rt. Rev. William Bacon Stevens was Protestant Episcopal bishop of the Diocese of Pennsylvania and first president of the university's board of trustees. He died in 1887.

Stoughton House. Dr. Bradley Stoughton was dean of the College of Engineering and Physical Sciences from 1936 to 1939.

Williams House. Dr. Clement G. Williams was president of the university from 1935 to 1944.

Dravo House (1948). This stone edifice is the university's largest single residential facility. It honors two brothers, Ralph M. Dravo, Class of 1889, and Francis F. Dravo, Class of 1887, who founded the Dravo Corporation, a Pittsburgh-based international construction company. Both men served as university trustees.

Drinker House (1940). This stone facility honors the memory of Henry S. Drinker, Class of 1871, who was president of the university from 1905-1920. He was the father of the late historian, Catherine Drinker Bowen, who was raised in the President's House.

McClintic-Marshall House (1957). This U-shaped stone structure was built in memory of Howard H. McClintic and Charles D. Marshall, both Class of 1888 graduates, who founded the McClintic-Marshall Construction Company. The firm became the world's largest independent steel fabricating firm before its merger with Bethlehem Steel Corporation in 1931.

Richards House (1938). The building honors the memory of Charles Russ Richards, president of the university from 1922 to 1935. The structure is stone with modified Gothic architecture.

RH-11 (1975). This contemporary seven-building, $1.86 million undergraduate apartment complex is located west of the University Center.

Saucon Married and Graduate Students apartments (1974). This five-building garden apartment complex on the periphery of the Saucon Valley campus houses undergraduates and graduate students. The university's three sororities plan to take up residence in the facility in the fall of 1977. The buildings in the $2 million complex are named as follows:

Diamond. Named for Dr. Herbert M. Diamond, of Bethlehem, professor emeritus of economics, who retired in 1964.

Gipson. Dr. Lawrence H. Gipson, research professor emeritus of history, bequeathed his $125,000 estate to the university to establish the Lawrence Henry Gipson Institute for Eighteenth-Century Studies. Before his death, in 1971, Dr. Gipson wrote a monumental fifteen-volume history, "The British Empire Before the American Revolution," for which he won the Pulitzer Prize.

Hartman. Dr. James R. Hartman formerly was chairman of the department of mechanical engineering and mechanics. He died in 1961.

More. Dr. Robert P. More, former dean of the College of Arts and Science, bequeathed to the university his $746,000 estate. The professor, who also taught German for forty years at Lehigh, died in 1970.

Severs. Dr. J. Burke Severs, of Bethlehem, is distinguished professor emeritus of English. He retired in 1969.

Taylor House (1907). This U-shaped concrete structure was the gift of Andrew Carnegie in honor of his friend and associate, Charles L. Taylor, Class of 1876.

Fraternity residences

The university has a strong fraternity tradition, dating back to 1872 when Chi Phi was established. The most recently established fraternity was Zeta Psi, in 1973.

Twenty-seven of the thirty-one Lehigh fraternities have houses located in the Sayre Park area of the campus, while the other four have houses off campus. The most recently built on-campus house is Kappa Sigma, built in 1975 at a cost of $550,000. Contributions for construction and support of fraternity dwellings are made by chapter alumni.

Fraternity chapters at Lehigh include: Alpha Chi Rho, Alpha Sigma Phi, Alpha Tau Omega, Beta Theta Pi, Chi Phi, Chi Psi, Delta Chi, Delta Phi, Delta Sigma Phi, Delta Tau Delta, Delta Upsilon, Kappa Alpha, Kappa Sigma, Lambda Chi Alpha, Phi Delta Theta, Phi Gamma Delta, Phi Kappa Theta, Phi Sigma Kappa, Pi Kappa Alpha, Pi Lambda Phi, Psi Upsilon, Sigma Alpha Mu, Sigma Chi, Sigma Nu, Sigma Phi, Sigma Phi Epsilon, Tau Epsilon Phi, Theta Chi, Theta Delta Chi, Theta Xi, and Zeta Psi.

LEHIGH'S RANKING AMONG ITS PEERS

How does Lehigh rank among other colleges and universities? The university has long been aware of the success of its alumni. For example, of the 15,550 Lehigh alumni involved with business and industry, twenty-one percent of them, or 3,432, are officers of companies or corporations. Twelve percent of this group are chairmen, partners, owners or presidents.

A 1974 study of U.S. business by Standard & Poor's showed that Lehigh ranked seventh nationally in the proportion of alumni who were officers or directors of major corporations. An earlier *Scientific American* study showed that Lehigh ranked within the top six colleges and universities in the nation in the

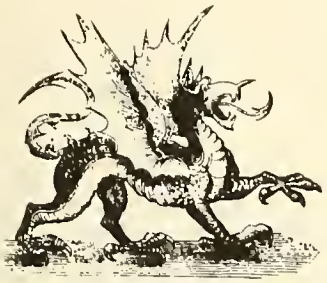

Fig. 804.—FABULOUS FIGURE OF A DRAGON.

proportion of alumni who had reached one of the top two positions in the nation's six-hundred largest corporations.

Some new documentation concerning Lehigh and its alumni became available during 1976 with the publication of the "Survey of Voluntary Support of Education, 1974-75." This survey, undertaken by the Council for Financial Aid to Education and the Council for Advancement and Support of Education, compares the relative merits of some sixty-nine private universities, including Lehigh, as well as a larger group including 876 colleges and universities.

Lehigh ranked eighteenth among private universities in alumni support, and twenty-sixth among the 876 schools surveyed. It ranked twenty-third among the universities in foundation support and fortieth in this category among the 876. In corporate support Lehigh ranked thirtieth among the sixty-nine, sixty-ninth among the 876.

Lehigh ranked fifth among both groups in corporate matching gifts received. Only Harvard, Dartmouth, Yale and Princeton received more matching gifts than Lehigh. The endowment market value ranked twenty-sixth among private universities and forty-fifth among the 876.

Speaking following the dedication of the chemistry complex, John T. Connor, former chairman of Allied Chemical Corporation, said: "I hold Lehigh in rather special esteem because it has played such a distinguished role in providing leaders for American business."

PRUDENCE KEEPS FINANCES STABLE

Students sometimes characterize the university's financial operation as "conservative." The university looks upon its policies as "prudent management." Either way, Lehigh has a tradition of operating in the black, and it has sustained deficits only a couple of times throughout its history.

During the fiscal year 1975-76, operating income of $26,541,593 exceeded operating expenses, transfers and appropriations of $26,387,508 by one-half of one percent, or $154,085, which, in accordance with directions from the board of trustees, has been credited to the university's reserve for operations to provide funds to meet future contingencies. These figures are subject to verification by the university's auditors.

The total income from the dining and residence cost center amounted to $3,391,916 which exceeded total expenditures and transfers and appropriations of $3,231,676 by $160,240 which was credited to reserve accounts to offset the 1974-75 deficit of $94,222.

Assets of the university include buildings and equipment valued at approximately $100 million and an endowment of approximately $56 million.

POLICY OF FAIRNESS

In accordance with applicable federal and state laws and regulations, it is the policy of Lehigh University not to discriminate in any way, whether it be with respect to employment, educational programs or otherwise, on the basis of race, sex, color, religion, creed, national origin or ancestory or because a person is handicapped or a Vietnam veteran.

THE COMMUNITY: A RARE TRADITION OF EDUCATION

Lehigh University shares in the rich historical heritage of Bethlehem, even though, having been founded in 1865, it is a relative newcomer.

The fact that Lehigh was established in Bethlehem reflects in large measure the tradition of education established by the first settlers more than thirty years before the founding of the nation.

The first Moravians were among the many German religious sects which came to the New World, and especially to Pennsylvania, during the early 1700s. Like William Penn, who established his *sylvania* as a new land where he might hold his Quaker beliefs away from England's oppression, the Moravians also were seeking refuge from religious persecution.

The early Moravians were industrious. Their first building, the Gemein Haus (community house) was completed in 1741. This fine building still stands today, one of thirty-nine remarkably preserved pre-Revolutionary War buildings constructed by the Moravian settlers. These buildings are located on East Church Street, west of the City Center; industrial buildings are located in the Monocacy Creek valley behind the Hotel Bethlehem.

The leader of the Moravians was Count Nicholas von Zinzendorf of Dresden. He had arrived in the settlement in time for their observance of Christmas Eve in 1741; hence the name Bethlehem.

The settlers built fine structures of stone, demonstrating principles of engineering that were not generally used elsewhere. But their principal interest was music, and they established the first symphony orchestra in America. In 1748, the settlement had a fourteen-man orchestra. The community's first organ was built in 1757 by John Gottlob Klemm. The great musical tradition, including the trombone choir, continues today, perhaps most visibly in the Bach Choir of Bethlehem, whose yearly Bach Festival is held in the university's Packer Memorial Church.

It is said that hostile Indians during the 1750s planned a night attack on one occasion, but the sweet music of hymns emanating into the silence of the night frightened off the invaders, who supposedly thought some godlike power protected the community.

Zinzendorf envisioned Bethlehem as the center of manufacturing; outlying settlements, such as Nazareth, Pa., would be primarily devoted to agriculture. On October 15, 1742, a large barn was "raised" with the help of most of the residents. Three months later a grist mill at the community spring produced the first flour. In 1758, the Sun Inn was built along Main Street, where it still stands today. It was a haven for travelers to the industrial community. The inn is now in the process of restoration and will serve as a focal point in the restoration of the Bethlehem business community.

The Sun Inn was used as a hospital during the Revolutionary War and counted among its patients an aristocratic renegade from France, Marie Joseph Paul Ives Gilbert Motier, better known as the Marquis de la Fayette. Lafayette had come to assist the Continental Army aboard his own ship, the "Victory." Fifty years later a college would be named to honor him.

The Moravians, although avowedly opposed to war, found their community transformed into a hospital when Washington's troops were at Valley Forge during the 1776-78 period. Benjamin Franklin, writing to the governor from Bethlehem, said: "We found this place filled with refugees, the workmen's shops and even cellars being crowded with women and children. . ." Washington came to the community once, and many other Continental Army officers were visitors to Bethlehem.

Zinzendorf's determination that Bethlehem would be a major industrial center was greatly assisted by the completion in 1755 of the water works, the first public utility in the New World and a masterpiece of engineering. The structure is now being restored.

The Moravian dedication to education was an extension of the philosophy of Amos Comenius, who had written, "Everyone ought to receive a universal education." The several Moravian educational institutions which continue today, including Moravian College, stem from this tradition.

It is interesting to note that the Moravians did not share with the other Pennsylvania Germans distinct dialects. They spoke, as one early observer phrased it, "the most correct German of which America can boast."

The first bridge across the Lehigh River was built in 1794, at a cost of $8,000. It was replaced by another bridge in 1816, but the latter was destroyed by a flood in 1841. In 1759, the turnpike (toll road) over South Mountain, generally along the route of the present Wyandotte Street hill, was placed in service.

During the late 18th century, the presence of anthracite was observed in the Lehigh Valley. In 1818, the Lehigh Coal Company and the Lehigh Navigation Company were formed, one to mine the anthracite on the upper Lehigh, the other to transport it downriver to Philadelphia and other metropolitan markets. Asa Packer and others who would be associated with Lehigh University were prime movers in this effort to transport fuel.

The Lehigh was difficult to navigate. Consequently, in 1829 the Lehigh Canal was completed from Asa Packer's hometown at Mauch Chunk (now Jim Thorpe) to Easton, passing through Bethlehem. At Easton it would connect with the Delaware Canal. During this period Bethlehem was involved in light manufacturing, such as paperboxmaking, combmaking, and trade in musical instruments. There was also a small iron foundry. During the 1840s, iron mines were opened in the area, and several blast furnaces, fueled by the easily accessible coal, were in operation. Zinc ore was found on a farm in Upper Saucon Township. These origins eventually led to the steel and zinc production which characterizes the Lehigh Valley today.

The community of Bethlehem has a population of about 78,000 persons. It is a diverse population with segments from a variety of nations who continue to retain the traditions of the country of their origin. The Moravian dedication to the principle of religious tolerance made Bethlehem an appropriate choice for settlement of these people or their forebears.

Bethlehem has two principal employers, Bethlehem Steel Corporation and Lehigh University. The steel company maintains its corporate headquarters in Bethlehem and also has a major manufacturing facility. Its Homer Research Laboratories, costing $50 million and employing eight hundred persons, is located adjoining the Lehigh campus at the top of South Mountain.

The university employs some 1,800 persons on a full-time or part-time basis, contributing significantly not only to the cultural and intellectual life of Bethlehem, but to its economic health as well. The annual payroll is approximately $17 million.

There are five colleges in the Lehigh Valley besides Lehigh, all private. They are Lafayette, Allentown College of St. Francis de Sales, Moravian, Muhlenberg, and Cedar Crest. A cooperative program is maintained among the colleges. There are also two two-year community colleges in the area.

Fig. 1390. — HEAD OF A BEE. (Considerably magnified.)

THINK ABOUT IT

Alfred North Whitehead wrote the following back in 1916. It is printed here because it relates well to the Lehigh University philosophy of education.

"In the conditions of modern life, the rule is absolute: the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will be pronounced on the uneducated."

UNDERGRADUATE ADMISSION

The enrollment of Lehigh University is regulated by action of the board of trustees, with a resulting limitation in the number of candidates who can be admitted each year to the several divisions of the university. The university is independent, nondenominational and coeducational, and accordingly seeks candidates without regard to race, color, sex, religious creed, or national origin.

In the selective procedure necessitated by enrollment limitation, the university, through its office of admission, takes into account a number of criteria which are believed to have some individual validity and in combination a high degree of validity in predicting probable success in college work.

Secondary school preparation

The admission policy of the university is designed to encourage students with varied backgrounds to consider Lehigh while insuring that any individual student is not guided into a program of studies for which he or she is inadequately prepared.

The courses or units required for admission represent the quantitative equivalent of the usual four-year college preparatory program and include certain prescribed subjects for candidates depending upon their college and curriculum choice.

An applicant's full potential as a Lehigh student, including evidence of academic growth and the desire to learn, are special qualities which may not be reflected in mere accumulation of units. Such qualities are taken into consideration.

All applicants should have completed four years of English, two to four years of history and social studies, three years of mathematics and two to four years of laboratory science. Chemistry is required and physics recommended for candidates planning studies in science or engineering.

Students planning to enter the College of Engineering and Physical Sciences or the College of Business and Economics, or the bachelor of science program in the College of Arts and Science, must have studied mathematics through trigonometry.

Students planning a bachelor of arts degree in the College of Arts and Science present at least two years of one foreign language. However, foreign language study is not mandatory.

One of the major features of Lehigh is the ease with which a student may normally transfer from one curriculum or college to another. Such transferring may, however, necessitate a student's obtaining additional background for the new discipline area on campus or elsewhere.

Summary of minimum subject matter requirements (16 units)

English 4
Foreign Language* 2
College Preparatory Mathematics** 4
Electives 6

*Waivers of the requirement in foreign languages are granted to otherwise well-qualified candidates for admission to all three undergraduate colleges.

**Waivers of the requirement in mathematics are granted to otherwise well-qualified candidates for admission who propose to major in one of the following fields offered by the College of Arts and Science: American studies, fine arts, classics, drama, English, modern foreign languages, government, history, international relations, journalism, music, philosophy, religion studies, social relations, and urban studies.

Note: Chemistry is required and physics is recommended for candidates planning programs in science, arts-engineering, and engineering. Electives should include such college preparatory subjects as languages, social studies, and sciences.

Quality of Work

The quality of the candidate's work is more important than merely meeting minimum subject matter requirements.

The strength of his or her preparation is judged primarily by the individual's rank or relative grade in class; by the extent to which the student has made grades distinctly higher than the average grade; by evidence of improvement or deterioration in quality of record as he or she progressed through secondary school; by relative success or failure in the particular subjects which the student proposes to continue in college; and by the comments and recommendations of the principal or headmaster.

Entrance examinations

All candidates for admission to the freshman class are required to write entrance tests prepared and administered by the College Entrance Examination Board. Tests required by Lehigh University are listed below.

Scholastic Aptitude Test

Each candidate is required to write the Scholastic Aptitude Test (SAT) to provide the university with a measure, on a national scale, of aptitude and readiness for college study. The university prefers that this test be written early in the senior year, unless satisfactory junior-year scores were submitted to Lehigh.

Achievement Tests

Each candidate is required to write three additional College Board Achievement Tests. One of these must be English Composition.

Candidates for a science program in the College of Arts and Science or for a program in the College of Engineering and Physical Sciences are expected to write a Mathematics (Level I or Level II) Achievement Test. Candidates for the College of Engineering and Physical Sciences are expected to write a Science (chemistry or physics) Achievement Test. Candidates for bachelor of arts program in the College of Arts and Science, including five-year Arts-Engineering candidates, should write an Achievement Test in the foreign language (if any) to be studied in college. Other candidates write tests which they may choose in consultation with their advisers. The English Composition and two additional Achievement Tests should be written in the senior year, unless satisfactory junior-year scores were submitted to Lehigh University.

Test information and applications should be secured from the College Entrance Examination Board at either of the following addresses (whichever is closer to the candidate's home or school): P.O. Box 592, Princeton, New Jersey 08540 or P.O. Box 1025, Berkeley, California 94701, or from the candidate's school.

Candidates should register for the tests early in the senior year and not later than one month prior to the test date (two months for candidates who will be tested in Europe, Asia, Africa, Central and South America, and Australia).

The candidate is responsible for requesting that the test score be sent to Lehigh—either by indicating Lehigh in the College Board application or, having failed to do this, by special request to the College Board office. In addition to requesting that the College Board scores be sent to Lehigh, the candidate must submit an application for admission to the freshman class at Lehigh.

Other criteria and interviews

Information about other qualifications of candidates is obtained from principals, headmasters, and counselors. Such information relates to the candidate's health, emotional stability, intellectual motivation, social adjustment, participation in school activities, and established habits of industry and dependability.

Each candidate is urged to visit Lehigh whenever possible so that he or she may see the university and talk with an officer of admission. An appointment should be made in advance of the visit. Write to Director of Admission, Lehigh University, Alumni Memorial Building, #27, Bethlehem, Pennsylvania 18015.

The office of admission is open for interviews every weekday between 9 and 11 A.M. and from 1:30 to 4 P.M. Tours of the campus are available every weekday afternoon, at which time classes are in session. Special arrangements may be made for Saturday afternoon during the school year, and all day Saturday during the summer months. Visitors are welcome during the summer months.

Although a personal interview is not required of all candidates, the university reserves the right to require an interview whenever this appears desirable or necessary and to base determination of admission in part on the report of the interviewing officer.

PROCEDURES

Admission to the freshman class

If a candidate has determined that he or she is sincerely interested in Lehigh and if the student believes that he or she will meet admis-

sion requirements of subject matter and school record, the individual should secure from the office of admission an application for the freshman class.

The application should be submitted early in the last year of preparation for college. Every effort should be made to submit an application during the fall semester of the senior year and definitely not later than March 1.

Application Fee

Each undergraduate application for admission to the freshman class or with advanced standing or to the General College Division must be accompanied by an application fee of $20. The check or money order should be made payable to Lehigh University. The application fee is nonrefundable in the event the candidate does not matriculate at Lehigh University. It is not applied toward tuition if the candidate matriculates. An application cannot be accepted without the fee.

Early Decision

Lehigh will give a candidate an early favorable decision on his or her application if the individual meets the following criteria: (1) Preliminary credentials, including Scholastic Aptitude Test scores, show clear qualification for admission to Lehigh; (2) The person is certain that Lehigh is the first choice of college.

On this basis the committee on admission selects candidates who have submitted requests for early decision by November 1. Lehigh's decisions will be made by December 1. If the decision is favorable, it is assumed the candidate's academic strengths will continue throughout the senior year and that he or she will complete all normal admission requirements. On receiving a favorable decision, the candidate promptly withdraws other applications.

Early-decision candidates whose parents have submitted Parents' Confidential Statements will receive notice by December 1 of the action taken on requests for financial aid.

The early-decision plan is not appropriate for all candidates. There are many candidates who are unable to make an early college choice. Such candidates are not penalized. Candidates who do not receive favorable replies to their requests for early decision should not feel discouraged. Only a portion of the class is selected under this plan, since the committee on admission prefers to take action on most applications later in the academic year.

Advanced Placement

There are several means whereby able students with superior preparation may obtain advanced placement and/or college credit at Lehigh.

In many secondary schools able and well-qualified students have opportunities to enroll in one or more Advanced Placement courses given under the auspices of the College Entrance Examination Board. Lehigh encourages students to enroll in these college-level courses and to write the Advanced Placement tests offered by the CEEB each May. Entering freshmen who ask the CEEB to submit their test scores and papers to Lehigh, and who are recommended by their schools, are considered for advanced placement and/or college credit.

Advanced Placement test scores range from a low of 1 to a high of 5. Students who earn the recommendation of their schools and scores of 3 or higher on the Advanced Placement tests receive advanced placement and/or credit in most departments. A few departments regularly offer special examinations during freshman orientation to students who completed college-level courses in secondary school, who did not write Advanced Placement examinations, and who request permission to write the tests. The current practices at Lehigh follow:

Biology. Advanced Placement and three semester hours of Lehigh credit for Biology 21 to students who earn scores of 3 or higher. Students may obtain an additional hour of credit for Biology 22 after consultation with the chairman of the department during freshman orientation.

Chemistry. Advanced Placement and five semester hours of Lehigh credit for Chemistry 21 and Chemistry 22 to students who earn scores of 3 or higher. Other students who earn scores of 750 or higher on the Chemistry Achievement Test of the CEEB receive equal credit. The department administers tests during freshman orientation to students who did not write the Advanced Placement examination and who wish to establish credit for the first Lehigh course.

English. Advanced Placement and six semester hours of Lehigh credit for English 1 and 2, 10, 14 or 16 (the standard freshman course) to students who earn scores of 3 or higher on the CEEB Advanced Placement Test in English. Other students who earn a score of 700 or higher on the SAT-Verbal Aptitude Test receive equal credit.

History. Advanced Placement and credit to students who earn scores of 4 or 5 on the American History of European History examinations. Consideration for advanced placement and/or credit to students who earn scores of 3. Special courses, History 51 and History 52, are available to students who earn Advanced Placement and/or credit. The department administers tests to students who wish to try to establish credit in introductory courses.

Latin. Students receive three semester hours of credit for a score of 3 or higher on the Vergil exam; those who write exams in more than one area (e.g., Vergil and lyric poetry) receive six semester hours of credit.

Mathematics. Advanced Placement and four semester hours of Lehigh credit for Mathematics 21, Analytic Geometry and Calculus I, to students who earn scores of 3 or higher on the Calculus AB examination; advanced placement and eight semester hours of Lehigh credit for Mathematics 21 and Mathematics 22, Analytic Geometry and Calculus I and II, to students who earn scores of 3 or higher on the Calculus BC examination. Other students, selected by the department of mathematics on the basis of entrance credentials, are invited to participate in an accelerated calculus sequence, Mathematics 31 and 32. Upon completion of Math. 31 and 32, each of which carries four credit hours, and upon certification of superior performance by the department of mathematics, the student receives four hours of advanced placement credit in calculus. The department also administers placement tests in any of its courses during freshman orientation to students who request permission to write a test.

Modern Foreign Languages. Advanced Placement and three semester hours of credit to students who earn scores of 4 on an Advanced Placement Test; advanced placement and six hours credit to students who earn scores of 5 on an Advanced Placement Test. Three semesters hours of credit are granted to students who earn scores between 670 and 740 on a CEEB modern language achievement test. Those students who earn scores of 750 or higher receive six semester hours of credit.

Music. Advanced Placement and three semester hours of credit to students who earn scores of three or higher.

Physics. Advanced Placement and five semester hours of credit for Physics 11 and 12, Introductory Physics I, to students who earn. scores of 4 or 5 on the Physics C examination or who earn scores of 5 on the Physics B examination. The department also administers placement tests to students who request permission to write a test.

International Baccalaureate. Students who write the International Baccalaureate are granted credit in those higher-level subjects in which they earn scores of 4 or higher.

Other Opportunities

The university encourages the initiative which secondary school students are showing in enrolling in advanced courses, in requesting advanced standing in college, and in assuming responsibility for a greater share of their own education.

Besides opportunities for advanced placement of freshmen, sophomores are invited to consider the advantages of enrolling in some junior courses. This may be accomplished by special examinations available in certain courses for students who performed particularly well as freshmen.

In the junior year students may register for interdepartmental honors seminars and in some programs may take "unscheduled work," where they have an opportunity to do individual work in consultation with a member of the faculty. In the senior year students may continue with the interdepartmental honors seminars and may undertake departmental honors programs. Particularly well-qualified students are permitted to take a limited number of graduate courses. Some students engage in research projects in connection with their senior thesis.

The opportunities for able and well-motivated students are increasing each year and more students are qualifying each year for advanced sections and courses and honors programs.

Acceptance of admission and deposit

Selection of candidates for the freshman class entering in September is made between the end of February and April 1 following receipt of College Board scores and preliminary secondary school records. Lehigh subscribes to the "Candidate's Reply Date," which has been set at May 1.

When a candidate's preliminary credentials are complete and the person has been offered formal admission to Lehigh University, he or she will be asked to notify the director of admission of acceptance of the offer of admission by making a deposit of $50 to hold the place for the student in the limited enrollment. This deposit is not an additional fee but is applied toward tuition charges for the first semester. However, the deposit is forfeited in case of failure to enroll for the specified semester.

Transfer Students

Candidates for admission from other institutions are admitted with advanced standing to the three colleges of the university. Such candidates must have met the subject matter entrance requirements prescribed for undergraduates at Lehigh. No entrance examinations are required.

A candidate who has studied at another college prior to applying for admission to Lehigh will be considered on the basis of the quality of his or her record at that college. A candidate who has been dropped from another college for disciplinary reasons or for poor scholarship or who is not in good standing at the former college is not eligible for admission to Lehigh.

A student who is planning to transfer to Lehigh University should so arrange his or her work in college that he or she will cover as many as possible of the subjects of the chosen curriculum at Lehigh.

A student who desires to transfer to Lehigh University from another college submits an application for admission (on a special transfer form) with a $20 application fee. The student must request each college previously attended to submit to the office of admission at Lehigh University an official transcript of the academic record. Catalog pages describing the courses completed at other colleges should be enclosed with the application. It is not necessary to send complete catalogs.

A candidate who has attended more than one university, college, or junior college must present a record from each institution. Failure to submit a complete record of former academic experience will result in cancellation of admission or registration.

COSTS AND ACCOMMODATIONS

UNDERGRADUATE EXPENSES

Tuition in Lehigh's undergraduate colleges is $3,825 per annum for 1977-78. The tuition for 1976-77 was $3,550. An increase for 1978-79 should be anticipated.

A student regularly enrolled in any of the undergraduate divisions of the university who registers for fewer than the normal hours of work in 1977-78 will pay either $160 for each semester hour carried, or the regular tuition, whichever amount is lower. Lehigh University reserves the right to change at any time the rules governing tuition and fees.

Items of personal expense are dependent upon each student's personal habits and circumstances. There are certain basic expenses in addition to tuition which must be met. For example, books, stationery, and drawing instruments may be purchased at the bookstore in Maginnes Hall at an average annual expense of about $185. This allowance does not include personal expenditures.

Since Lehigh is primarily a residential university, provision is made for student living quarters and dining facilities, and social fraternities or sororities. In most cases, students living in campus residence halls are required to eat in university dining facilities. Six meal plans are available, and are described later in this section. There are no fees for athletics, health service, library, student activities, or student concerts and lectures. In addition, there are no matriculation, graduate, or laboratory fees.

Undergraduate fees are payable prior to registration. A bill will be rendered by the bursar's office which will indicate the payment date. If desired, payment may be made in installments of 60 percent, plus a service charge of three dollars per semester, due prior to registration, 20 percent due one month after registration, and 20 percent due two months after registration. The service charge is not refundable.

Fig. 587. — A CIVIL OFFICER.

Residence halls

More than half of Lehigh undergraduates live in university residence halls. Lehigh has eight principal residence halls for undergraduate men and women. Most rooms are designed for two students, but a limited number of single, triple, suite arrangements, and apartment units are available.

Residence units include the following: Dravo, Drinker and Richards houses, comprising the so-called "freshman quadrangle"; McClintic-Marshall House; Taylor House; the Centennial I and Centennial II residence groupings; the Residence Halls I1 complex (student apartments); Bishopthorpe Residence; and the Saucon Married and Graduate Students apartment complex on the Saucon Valley campus.

Room rental charges in the residence halls range from $352.50 to $450 per semester in 1977-78. An additional charge of $45 to $60

per semester is made for single rooms. In most residence halls all essential furniture is provided. Rooms are rented on an annual lease basis only.

For 1977-78, the cost of rooms per annum is as follows: McClintic-Marshall House, $755; Centennial I and II, $795; Residence Halls 11, $900; Dravo, Drinker, Richards and Taylor houses and Bishopthorpe Residence, $705.

When a candidate accepts an offer of admission to the freshman class, the candidate is sent a Room and Board Application-Contract. Those desiring accommodations in the residence halls return this application-contract promptly because priority of assignment is based on date of receipt of this application. A nonrefundable advance deposit of $100 must accompany the application. The deposit will be credited to the fall semester room and board charges. Normally freshman room assignments are made in early August by the residence operations office.

Currently, the demand for upperclass campus housing exceeds the supply by approximately ten percent. For the duration of this imbalance, the University Forum has approved the use of in-class lotteries to provide for fair and equitable distribution of available housing among upperclass students. Lotteries are scheduled early in the spring semester. Those students who are guaranteed housing pay a $100 deposit to hold the space for the following academic year.

Each student in the traditional residence halls is provided with a bed, mattress, chest of drawers, and chairs. Residents supply such personal items as pillows, wastebaskets, quilts, ashtrays, and radios. Most residents supply their own desk lamp. Students may supply their own bed linen and towels and make their own arrangements to have these laundered, or they may subscribe to a linen service which provides clean bed linen and towels each week. A coin-operated laundry service for student use is available in close proximity to each residence hall.

Residents are held responsible for damage done to their rooms or any other part of the residence halls and their equipment.

The university is not responsible for the loss or destruction of any student property whether such losses occur in the residence halls, lockers, classrooms, etc. The safekeeping of student property is the responsibility of each individual student and no reimbursement from the university can be expected for the loss of such property. Insurance protection, if desired, may be obtained by a student or his or her parents from an insurance broker or agent.

Information on off-campus housing may be secured from the residence operations office.

Child care facility

Child care is available on a limited basis for the children of Lehigh students, staff and faculty at the Campus Center. The center, which was started in January, 1977, is a joint effort of the Lehigh University Committee on Child Care and Lehigh Valley Child Care, Inc.

Children between the ages of six weeks and five years can be enrolled in the center on a first-come, first-serve basis. Both full-time and part-time care are available. Fees are charged on a weekly basis. Limited scholarship aid may be available for those with financial need.

The Campus Center, which is near Lehigh's campus, operates five days a week from 7:30 A.M. until 5:30 P.M. It is open year-round.

Those desiring more information should contact the community relations office, Johnson Hall, #36, Bethlehem, Pa. 18015.

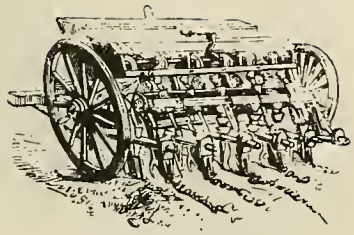

Fig. 572 — DELL.

Social fraternities and sororities

Approximately one-third of the male students live in fraternity houses. Such accommodations are available to upperclassmen who receive invitations to join the groups.

Three national sororities were recognized by the university in 1975. They are Alpha Gamma Delta, Alpha Phi and Gamma Phi Beta. Each sorority was expected to operate its own house in the Saucon Valley housing complex effective fall, 1977.

Of the thirty-one social fraternities with chapters at Lehigh, twenty-seven occupy houses on the campus. The remaining houses are in Bethlehem near the campus. Freshman are "rushed" during the first semester of the freshman year, but they usually do not move into fraternity houses until the sophomore year.

Many commodities and services needed by the fraternities are provided by the cooperative Fraternity Management Association (FMA). Students who accept invitations to live in fraternities are required to formalize their acceptance in a written contract with the fraternity. These contracts are based on budgets prepared with the FMA and approved by the fraternity chapters and alumni corporations. These contracts are binding in the fraternity segment of the university's residential system. Accordingly, upon registration for the academic period covered by contract, fraternity members are obligated to pay approved fraternity bills through the university.

Living costs in fraternities vary with the individual chapters but are generally of the same order of expense as residence (room and board) in university-operated halls.

Fraternities, all nationally affiliated, include the following: Alpha Chi Rho, Alpha Sigma Phi, Alpha Tau Omega, Beta Theta Pi, Chi Phi, Chi Psi, Delta Chi, Delta Phi, Delta Sigma Phi, Delta Tau Delta, Delta Upsilon, Kappa Alpha, Kappa Sigma, Lambda Chi Alpha, Phi Delta Theta, Phi Gamma Delta, Phi Kappa Theta, Phi Sigma Kappa, Pi Kappa Alpha, Pi Lambda Phi, Psi Upsilon, Sigma Alpha Mu, Sigma Chi, Sigma Nu, Sigma Phi, Sigma Phi Epsilon, Tau Epsilon Phi, Theta Chi, Theta Delta Chi, Theta Xi and Zeta Psi. Locations of most houses may be found on the university map.

Dining services

The six board plans available for 1977-78 include the following:

Plan A. Twenty-one meals per week at $440 per semester. This includes three meals daily.

Plan B. Seventeen meals per week at $407.50 per semester. This includes Monday breakfast through and including Saturday lunch.

Plan C. Fifteen meals per week at $395 per semester. This includes Monday breakfast through Friday dinner.

Plan D. Ten meals per week at $380 per semester. This includes lunch and dinner Monday through Friday.

Plan E. Five meals per week at $250 per semester. This is for dinner from Monday through Friday.

Plan F. Five meals per week at $140 per semester. This is for luncheon from Monday through Friday.

The board plans begin with luncheon before the first day of classes and continue, except for announced holidays, through the noon meal of the last day of the examination period each semester.

Plan A is required for freshmen residing on the campus. Upperclassmen residing on the campus have the choice of any of the four major plans (A through D). Five-meal plans are limited to commuting students, residents of SMAGS, and occupants of apartments in RH-11.

The board plans and the student dining rooms are open primarily to students of the residence halls. These plans may be extended on a limited basis to students who do not live in residence halls. Students who do not live in the residence halls may apply to the bursar for participation in one of the dining plans.

Freshmen residing on the campus are required to eat their meals in the university dining facilities during freshman orientation. There will be an additional charge for serving the three meals per day during freshman orientation.

Each student who participates in one of the board plans will receive a dining service identification card which is not transferable. Use of the card by someone other than to whom it is issued is not permitted. New cards will be issued to replace lost cards upon the payment of a fee of $10.

Visitors on campus may dine in the Asa Packer Room, the faculty and guest dining room located on the third floor of the University Center. A snack bar on the second floor of the University Center is open to all students and visitors.

Special fees

ROTC and Band. Students taking ROTC and/or Band reimburse the university for returnable equipment which has been lost or damaged.

Chemistry breakage. Students taking chemistry laboratory courses reimburse the university for returnable equipment broken or otherwise damaged and for all chemicals used in excess of reasonable amounts.

Examination fees. Students who for satisfactory reasons absent themselves from final examinations will be allowed, upon petition, to take makeup examinations without payment of an examination fee. A fee of $5 is charged for any examination subsequent to the first regular final or makeup examination allowed upon petition in any course. This regulation applies to the psychological and placement examinations required of new students if taken at some time other than those scheduled.

Late registration fees. The cost of procuring a registration ticket after the time specified by the registrar is $10. A student who does not complete registration within three days after the date of the registration ticket is subject to a penalty of $10. No registration will be later than the tenth day of instruction in a regular semester or the fifth day of instruction in any summer term.

Late preregistration fee. The penalty for late preregistration or a change in preregistration is $10. This will be waived for cause upon the recommendation of the college dean.

Change-of-roster fee. Having once registered in any semester, a student may not drop any course except on the recommendation of the director of his or her curriculum. There will be a $10 change-of-roster fee for each change unless it is waived by the college dean.

Late installment payment. In certain cases, students are permitted to pay semester bills in three payments. In other cases, emergency short-term loans are granted to be repaid in period installments within the semester in which the loan is granted. A penalty fee of $10 is levied on any student who fails to make payment in accordance with the agreed schedule.

Late payment of fees. University fees are payable prior to registration. If payment, or provision for payment satisfactory to the university, is not made prior to registration, a fee of $10 will be assessed if such payments, or provisions for payments, are made after the registration date.

Late application for degree fee. A fee of $10 is charged for late filing. See Notice of Candidacy for Degree, page 25 for dates.

Application for admission fee. A fee of $20 is required with each application for admission to the undergraduate colleges of the university.

Listener's fee. Undergraduate students enrolled in less than a full program who wish to attend a course or courses without obtaining credit will be charged a listener's fee equivalent to the tuition cost of one credit hour for each such course attended.

Transcripts. Each student is entitled to one copy of his or her record free of charge. This can be an official or unofficial transcript. Unofficial copies are released to the student; official copies are sent directly to the educational institution, company, state board, etc., as the circumstances may require. After the first copy is released a fee of $1 is assessed for each subsequent copy.

Refunds

Tuition. In the event of the death of a student or involuntary induction into the armed forces, tuition will be refunded in proportion to the fraction of the semester remaining at the time the student leaves.

If a student withdraws from the university, he or she is entitled to receive a refund of tuition less $100 and less a deduction of two percent of the tuition for each day of instruction completed, computed from the first day of instruction in the semester. No student who is suspended or expelled from the university receives any refund.

A summer session student who formally withdraws from the university is entitled to receive a refund of total tuition less $5 for each credit hour for which the student is registered and less a deduction for each day of regular instruction of four percent of the total tuition paid computed from the first day of instruction in the session.

Refunds will be made through the tenth day of instruction in a regular semester to undergraduate students for reductions of schedules below twelve credit hours (full time). The refund shall be in an amount equal to the number of credit hours remaining multiplied by the credit hour rate deducted from the semester tuition paid. Refunds will be made through the fifth day of instruction in the summer session for reductions of schedules in an amount equal to the credit hours dropped multiplied by the credit hour rate. No refunds will be made to any undergraduate student for any reduction in schedule after the tenth day of instruction in a regular semester or the fifth day of instruction in a summer session.

Residence hall rental and dining service charge. Residence hall rooms are rented on an annual lease basis only. A student who signs a Room and Board Application-Contract is expected to occupy a room in the residence halls for the full college year.

An advance deposit of $100 on residence hall rental and dining service charges is required with the signing of the contract. The deposit will be credited to the fall semester room and board charges.

A full refund of all residence hall rental and dining service charges paid, including advance deposits, will be made in the event a student does not register because of illness, injury, death, induction into the armed forces, or if the student is dropped from the university for academic reasons. In such cases the university must be notified within ten days to be eligible for refund. Should the student be readmitted to the university for the following fall or spring semester and there are accommodations available in the residence halls system at the time of readmission, the student is bound by the contract to accept residence halls accommodations. Except for the reasons stated above, no refund will be granted to incoming freshmen.

No student who is suspended or expelled from the university for disciplinary reasons is entitled to any refund of deposit or residence hall room and dining service charges.

Currently enrolled students who sign Room and Board Application-Contracts in the spring for residence as upperclassmen in the following year are entitled to a partial refund of advance deposit if the following requirements are satisfied:

a. In the event of voluntary withdrawal from the university.

b. In the event of desired voluntary withdrawal from the residence halls if the lease can be transferred to another student for whom no other accommodations exist. If the lease cannot be transferred to another student, for whom there are no other accommodations, there will be no refund of deposit and the student will be held liable for the full

amount of the residence halls and dining service charges contracted.

c. Partial refund schedule:

notification received by the university on or before	amount of refund
May 1	$60
July 1	$40
August 15	$20
after August 15	no refund

A refund of residence halls rentals and dining service charges will be made on a proportionate basis after registration in the event of a student's involuntary withdrawal from the university due to illness, injury, death, or induction into the armed forces. In the event of voluntary withdrawal from the university, no refund will be made except in the case of a transfer of lease to another student for whom no other accommodations exist. In the event of a transfer of lease to another student under these conditions, a proportionate refund of residence hall rental and dining service charges less $50 will be made. The maximum proportionate refund cannot exceed the total of residence hall rental and dining charges less $100.

No residence hall or dining service refund will be considered until (and date for calculation of proportionate refund will be determined by) such date that room is vacated and door key(s) and dining service meal ticket are returned to the residence operations office.

A student who forfeits a room and dining service reservation in the fall semester and who returns to the university in the spring semester is still obligated for room rental and dining service charges for the spring semester providing such facilities are available.

A refund shall be certified to the bursar by the residence operations office.

Payment. All refunds, including overpayments of charges resulting from scholarship awards, loans, financing arrangements with banks, etc., will be made by check payable to the student. A minimum of ten days is normally required to process refund checks.

FINANCIAL ASSISTANCE

Lehigh extends grant and self-help opportunities to deserving and promising students who would not otherwise be able to attend the university, to the extent that funds are available for such assistance.

Approximately twenty-six percent of the present undergraduate enrollment has received university assistance. In addition, outside grants and loans were awarded to Lehigh students from programs sponsored by the Commonwealth of Pennsylvania, military science and aerospace studies (ROTC) programs, and many private and state-sponsored organizations.

How to apply for aid

To be equitable in the awarding of financial assistance, Lehigh requires that "need" must first be clearly evidenced. Families are required to file the Parents' Confidential Statement, or the Financial Aid Form, with the College Scholarship Service, and all applicants, whether they are entering freshmen or upperclass renewals, are required to submit directly to the office of financial aid a notarized copy of their parents' 1040 income tax return statement.

Once need has been established, the committee on undergraduate financial aid endeavors to assist as many well-qualified applicants as funds will allow. An increasing number of students have been aided since the advent of the "package" concept of awards, wherein a student receives a combination of grant assistance and self-help (loan and campus employment). Self-help allows the student a greater degree of personal involvement in the financing of his or her own education.

In the competition for financial aid funds, emphasis is placed upon exceptional academic achievement and promise, commendable participation in activities outside the classroom, and good citizenship. Awards are made on a yearly basis. For an award to be renewed, an updated Parents' Confidential Statement is required to establish continued evidence of need and the level of assistance indicated. Continuation of an award assumes that the recipient will continue to show scholastic excellence and leadership activity commensurate with the promise shown when the award was originally made.

Eligibility for funds

A special scholarship application is not required by Lehigh. Requests should not be made for a particular type of scholarship. The submission of a College Scholarship Service form before January 15 establishes the candidate as an applicant for all types of financial aid for which he or she is eligible.

The committee on financial aid makes first selections in March and notifies all candidates promptly.

All upperclassmen applying for financial aid consideration may obtain their applications from the office of financial aid at the beginning of the spring semester. A renewal application includes a Financial Aid Form, the Lehigh application, and a notarized tax statement (IRS Form 1040). The committee on financial aid reviews upperclass applications within three weeks of receiving grades for the spring semester and notifies applicants as promptly as possible.

Transfer applicants for aid consideration are reviewed with the freshman group, provided that the admission and financial aid dossier is complete.

Sources of assistance

Trustee scholarships. These are awards covering the tuition charges in whole or part, provided by allocation of the board of trustees from general funds in order to supplement endowed scholarships.

Endowed and supported scholarships. These, are provided by individuals and by corporations either through endowments or by annual contributions, and are granted to able and deserving students who otherwise would not be able to attend college.

Leadership awards. While still requiring evidence of genuine financial need, good scholarship, and good citizenship, these awards place more emphasis on leadership attainments in nonacademic activities. These include Alumni Student Grants provided for good students with both aptitude and achievement in athletics. Leadership awards are restricted in terms of the particular qualifications and interests of the applicants as indicated in each instance.

Lehigh University Merit Scholarships. These are granted in cooperation with the National Merit Scholarship Corporation. The corporation and Lehigh annually award up to twenty four-year Merit Scholarships financed through the university's Annual Fund. The National Merit Scholarship Corporation conducts the competition for these scholarships as well as all others under its supervision. Final selection of Lehigh University Merit Scholars is limited to Merit Finalists who wish to attend Lehigh University and are qualified to do so. The individual stipend is based on the candidate's need as estimated by the university and is adjusted annually according to the financial status of parents, parents' savings and the student's savings and ability to earn funds during vacation periods. Stipends range from $100 to $1,500 per year.

Tuition loans. Such loans are made on the basis of merit and need, at the discretion of the committee on undergraduate financial aid to the extent that funds are available. No loan can be made to a student on scholastic or disciplinary probation except with the unanimous consent of the committee. The maximum indebtedness to the university that any student may normally incur will generally not exceed one-half of total tuition obligations up to and including the semester for which he or she is seeking tuition aid.

Each student qualifying for a tuition loan is asked to sign a note, endorsed by his or her parents or guardian. A repayment schedule satisfactory to the university may be arranged through the office of financial aid.

Fig. 1287. — THE BLACK-NECKED STILT, (*H. nigricollis.*)

Short-term loans. These are emergency loans and must be repaid, according to an acknowledged schedule, before the end of classes of the semester for which they are granted. Short-term loans bear interest from the date of the note. A minimum interest charge of fifty cents is made for each short-term loan granted.

The maximum amount for which a short-term loan may be granted, whether for tuition or for other purposes, is sixty percent of the student's total bill to the university for that semester. Short-term loans cannot be used in conjunction with the deferred tuition plan.

Every student incurring indebtedness to the university is required to undertake to pay the debt in full as rapidly as possible. Prompt repayment of loans insures the availability of a continuing fund to help other students.

Programs sponsored by the U.S. Office of Education. These consist of the Supplemental Educational Opportunity Grant (SEOG) program, the College Work-Study Program (CW-SP), and National Direct Student Loan (NDSL) program. All recipients are selected by the university. The Basic Educational Opportunity Grant program (BEOG) is a federal program making payments directly to the student.

SEOG is for students of exceptional financial need who without this grant would be unable to continue their education. Grants up to $1,000 a year are available for four years of undergraduate study, and are matched with at least an equal amount of university assistance.

CW-SP assists students by providing job opportunities either with the college itself or with private or public nonprofit agencies working in cooperation with Lehigh. Students may work an average of twenty hours weekly, with pay determined by the university.

NDSL makes it possible for the university to make loan awards up to $1,500 to needy students. The financial aid officer determines eligibility. Repayment begins nine months after graduation or termination of at least half-time study and may extend over a ten-year period. Interest charges of three percent also begin at the start of the repayment period. No repayment is required and no interest is charged for any period up to three years of service in the armed forces, Peace Corps, or VISTA. Graduate students are eligible to borrow up to $2,500 per year, with deferment of previous loan repayment.

BEOG is a direct-aid program providing nonrepayment aid for undergraduate study. Applications are available from high school guidance officers and Lehigh's financial aid office. Maximum awards vary, annually, with the federal funding level.

State programs. These are important sources of both grant and loan assistance. Students residing in Pennsylvania may be eligible for a Pennsylvania Higher Education Assistance Agency grant-in-aid up to $1,200 per year. Current high school juniors and seniors obtain information from their guidance office. College students are advised to check with the office of financial aid. Lehigh students also have received grant assistance from New Jersey, Massachusetts, Rhode Island and Connecticut.

Guaranty loan programs exist in most states, allowing students to borrow up to $2,000 annually with low interest and deferred repayment. Applications may be obtained at participating lending institutions.

Presidential Prizes. The Presidential Prizes are awarded to entering freshmen based on merit and without regard to financial need. They are described in the Special Academic Opportunities section, page 33.

SERVICES FOR THE STUDENT

GUIDANCE AND ASSISTANCE

General counseling of individual students, especially in the freshman year, begins with the residence halls counselors. These counselors are carefully selected upperclassmen, appointed by the president of the university, who help the first-year students and who direct them to more highly specialized aid when needed.

Freshmen whose problems transcend the competence of the residence halls counselors come to other advisers for guidance in many areas of student life and welfare. Problems of vocational choice and academic adjustment are not uncommon, particularly during the freshman and sophomore years. At all levels, academic and procedural questions, personal problems, social adjustment difficulties, and many other troubles are dealt with daily.

The office of the dean of students serves as a central agency in helping students to meet their problems and concerns, both through its staff and through referral to other student personnel and academic offices. Members of the dean's staff interview each freshman individually during the first year.

Each student in the College of Arts and Science is assigned a freshman adviser with whom the student discusses academic interests prior to registration. The choice of studies is carefully organized in terms of specific backgrounds of preparation and future objectives. Individual counseling continues throughout the student's four years in the college. In the College of Business and Economics, faculty advisers work with the student concerning his or her individual problems for the same purposes. Similarly, the associate dean of the College of Engineering and Physical Sciences curriculum spends much time with the freshman engineering students in an effort to help in the adjustment of academic difficulties and in better definition of vocational objectives. These forms of advisement are carried on through the following years with the student's academic advisers.

A student's problems often reveal the need of more highly specialized attention, whereupon the student is referred to the particular service which should be consulted. Problems of mental or physical well-being are, of course, referred to the University Health Service which is described below. The university chaplain is available for the student with religious, moral, or personal concerns that are interfering with his or her peace of mind and studies.

If a student is uncertain about vocational plans or needs to know more about his or her own capacities, interests or personal characteristics, the University Counseling Service is available without charge. Confidential interviews may be secured by any student who wishes to review his or her own progress and further evaluate and refine his or her thinking about future goals. Services offered include personal counseling for those students who may need and desire it.

Later, in the senior year, the question of prime importance is the decision on a position after graduation. The director of placement services, in personal and group conferences, advises on applying for a position, on being interviewed, and on the relative advantages, and disadvantages in working for the different business and industrial firms and other employers seeking the services of college graduates.

Financial problems can become a serious hazard for a student. The director of financial aid is available for consultation on these problems.

If a student is a veteran of military service and has questions involving relations with the Veterans Administration, he will find the registrar informed in this field. The registrar also is an adviser on military service, on matters of transferred credits, graduation requirements, and allied topics.

A serious hazard to success in a student's academic life may be in poor study habits or reading skills. The College Reading Improvement and Study Skills Program (CRISP) can provide help. See page 21 for further information.

Not all student problems are individual problems. Many are group problems, having to do with group living in the residence halls, with student activities, student organizations of many kinds, fraternity life, and campus social life in general. The deans and their assistants give much time to these areas of student life.

Many members of the teaching faculty are deeply interested in students and student life and spend a great deal of time working with student groups. They contribute their services as academic advisers, activity sponsors, group sponsors and advisers, by entertaining in their homes, and in friendly personal relationships with students.

In these and in other ways Lehigh University endeavors to maintain the close contacts with students which characterize the smaller institution. Services are available for all student needs, and the student need only turn to his or her nearest residence hall counselor, professor, or closest campus friend to learn where help can be obtained.

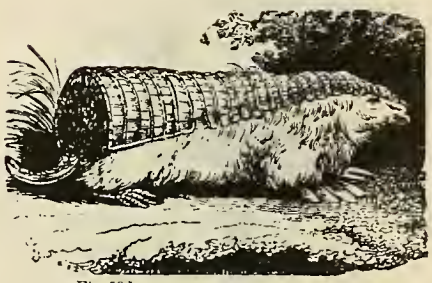

Fig. 592. — CHLAMYPHORUS TRUNCATUS.

Student Health Service

A dispensary is maintained which is equipped and staffed for routine medical and minor surgical care. Routine care provided by the regular Health Service physicians, nurses and others is provided at no cost to students. Dispensary hours are regular university office hours during the week, and Saturday mornings.

A night medical attendent is on duty through the fall and spring semesters. Facilities are available during these hours for the treatment of minor injuries and illnesses. A physician is on call at all times during the fall and spring semesters.

Patients requiring more than a few days of bed care are sent home or to a local hospital when indicated. Expenses so incurred must be paid by the student.

Due to limited staff and multiplicity of dispensary duties, Health Service physicians are not able to make professional calls on

students in living groups or in rooms, except in cases of absolute emergency. If unable to visit the dispensary in the event of illness or injury, students are advised to call local physicians for treatment. Such physicians' fees will be paid by the student, the family, or a health insurance plan.

The Health Service desires to work closely with the student's family physician and, as far as possible, will continue any treatment or follow-up requested.

Physical Examinations. Prior to arrival on campus each new undergraduate student is required to submit a Health History Form and Record of Physical Examination completed and signed by the family physician. It is essential that all parts of this form be completely answered by the student and the examining physician to be eligible for registration. At the appropriate time these forms are mailed to new students with specified date for return to the Health Service.

The physicians of the Health Service analyze the results of all physical examinations in order to detect any latent or obvious physical, emotional, or mental abnormality. When found, a person involved may be invited for a conference and the disability discussed with the student confidentially.

Close cooperation between the department of intercollegiate athletics, intramurals and recreation and the Health Service permits the establishment of rehabilitation measures, as indicated.

Immunization. It is highly recommended that all new students and transfer students show evidence of immunization to, or booster dose of, tetanus toxoid vaccine within the last six years.

Personnel. Full-time Health Service personnel normally include three physicians, a physiotherapist, a laboratory technician, two registered nurses, two night medical attendants, an administrative assistant, and a receptionist.

Accident and sickness reimbursement insurance. The university offers students insurance coverage against accident and sickness at nominal cost, and on an entirely voluntary basis.

The Health Service highly recommends this insurance plan to both present and prospective students. Past experience has emphasized the importance of such protection. All students are urged to participate in this plan throughout their college careers. The policy covers such items as prescription drugs, outpatient X-rays, and consultations which are not covered by the usual hospitalization policies.

All foreign students and others who, in the opinion of the administrative officers of the university, may not be in a position to meet the costs of accident or sickness are usually required to carry insurance.

The Health Service is located in Johnson Hall, in close proximity to residence halls and fraternity houses.

Counseling Service

The university is actively interested in the progress of its students as they pursue their educational and personal goals and desires to provide assistance should difficulties arise during their college years.

The Counseling Service, located in Johnson Hall, offers the opportunity for consultation with clinical psychologists and other counselors in regard to a wide variety of problems ranging in severity from those concerns that arise during the course of normal development to more debiliting emotional disturbances.

In cases where pertinent and objective information about academic ability, vocational interest or social-personal adjustment is desirable, psychological tests are often administered. Such test batteries are available at every student's individual option. Interpretation of these tests is intended to help the student achieve maximum effectiveness in his or her course work and studying, professional development and campus life. The test scores are utilized as only one of a number of sources of information important to wise and effective planning.

A library of educational and occupational information is maintained by the Counseling Service, to which students can refer as they attempt to develop a clear conception of the educational and vocational world and their place in it. Additionally, cross-communication with other university personnel agencies is maintained in gathering together information and expending plans made cooperatively with the student.

When a student in generally uncertain, confused and unable to plan for the future with confidence, or experiencing frustration with his or her studies and choice of major, or very unhappy about his or her social success and ability with people, he or she may undertake personal counseling aimed at helping the individual understand his or her direction and motivation.

Psychotherapeutic counseling, in particular, encourages the student to explore the sources of his or her feelings, to consider their influence on behavior and to discover new ways to manage one's own affairs more effectively. In these instances personal psychotherapeutic interviews would be intense and likely to involve conferences over an extended period of time.

Both testing and counseling services are available, without cost, to all university students and all interviews are held in confidence.

Although student counseling is its major professional activity, the Counseling Service is also the administrative center of a variety of local and national testing programs in which students might wish to participate during their college career. The most frequently administered of these programs are the Graduate Record Examination, Law School Admission Test, Graduate Management Admission Test, National Teacher Examination and Miller Analogies Test.

The service also engages in research on tests, counseling and other functions. The results of such research are ultimately useful in the counseling of individual students.

UNIVERSITY RESOURCES

Libraries

University library resources, representing more than 635,000 volumes, are housed in two buildings. Linderman Library contains 500,000 volumes in the humanities and social sciences, as well as the Rare Book Collection of 6,000 volumes. The structure is comprised of the unique semi-circular 1878 edifice designed by Addison Hutton and a Gothic addition built in 1929. Mart Science and Engineering Library, a contemporary structure, honors father-and-son alumni Leon Mart and Thomas Mart and houses 130,000 volumes in the natural and physical sciences, mathematics, and engineering.

The Linderman collection reflects academic strengths in English and American colonial history, and English literature. The library also serves as a depository for United States and Pennsylvania state government documents and United Nations publications. The music listening room provides facilities for the enjoyment of an extensive tape collection. Important original editions in the history of science, the Renaissance, and in American literature are among the treasures preserved in the university Rare Book and Robert B. Honeyman collections.

In addition to its strengths in engineering and the sciences, Mart Library also houses the international Wiswesser Line Notation File, a collection of publications related to the development of this method of chemical formula notation. An all-night study room is available to students in Mart. The Center for Information Science also in located in the building.

The libraries receive more than 7,500 periodicals and serials, including foreign and domestic newspapers. The collection is accessible to faculty and students in open stacks. Circulation is completely automated. Resources of the library system are augmented by membership with the Lehigh Valley Association of Independent Colleges, the Center for Research Libraries and the Ohio College Library Center.

The university library staff is dedicated to a service-oriented philosophy and to the provision of programs which stimulate the use of the library system as a vibrant intellectual and information resource. Direct personal assistance is available from an active reference staff who provide instruction in research methodology, library orientation workshops, and standard literature services such as interlibrary loan, and bibliographic compilations including the production of several ongoing current-awareness bibliographies.

During the academic year, library hours are 8 A.M. to midnight Monday through Saturday, and noon to midnight Sunday.

Reading and Study Clinic (CRISP)

There are many factors which influence the performance of college students. An important one is the expertise with which they master the skills necessary for college work.

High-level skills are needed in preparing assignments, note-taking, outlining, listening, recalling information and facts, taking exami-

nations, preparing written and oral reports, and reading critically and accurately.

The College Reading Improvement and Study Skills Program (CRISP) offers Lehigh students an opportunity to develop satisfactory reading and study habits. The following services are available to all students: analysis of reading and study skills, reading and study improvement programs, and individual guidance on problems of academic adjustment.

First-year students, particularly, are encouraged to arrange for a conference so that they can be assisted in making an evaluation of their learning tools and in planning for more effective work.

The improvement programs are offered periodically during the fall and spring semesters. Small group instruction is scheduled for interested students. The instruction is adapted to the needs of the individual in well-equipped facilities located in the Saucon Valley education complex.

Placement Services

The university provides centralized placement services for engineering and physical sciences, business and economics, and arts and science seniors, graduate students, and alumni seeking to meet their postgraduate plans.

Among the objectives of Placement Services, located in Christmas-Saucon Hall, is to help students learn the dynamics of the investigative and decision-making processes involved with postgraduate plans. An additional objective is to help students and alumni learn how to seek, interpret, and integrate career and occupational information into their interests, objectives and goals.

Each year, several hundred employer representatives come to Lehigh to interview candidates. In addition to on-campus interviews, many employers seek candidates by direct referral. The Placement Services staff helps to arrange interviews for prospective employers by means of a system of information flow between employer and student. In addition, the staff serves as a resource for students and alumni as they develop professional goals and career plans. Current occupational information and assistance for students seeking summer employment also are provided.

STUDENT ACTIVITIES

Extracurricular activities provide special opportunities for students to participate in interest groups and programs of their own choosing, all of which provide significant opportunity to develop qualities of leadership.

At Lehigh the philosophy of extracurricular activities is to allow the students as much opportunity as possible for setting their own policies, devising their own programs, and assuming full responsibility for their organizations. This philosophy makes it possible for the activities to be extremely significant in the personal development of participants.

The University Forum

Since 1970, Lehigh University has been governed in certain respects and otherwise widely influenced by a unique deliberative body known as the Forum. Its membership includes sixty faculty members, sixty students and five members of the university administration, among them the president.

Four Forum representatives, two students and two members of the faculty attend meetings of the board of trustees. Assured of access to the information upon which administrative decisions are based and free to inquire into any aspect of Lehigh's operations, the Forum affords faculty and students a voice in university affairs equaled at few other American institutions.

The Forum has legislative responsibility to set policy on academic program and planning in such areas as freshman seminars, high immediate relevancy courses, and the academic calendar; social life and regulations, extracurricular activities, and athletics; and areas of academic environment such as pass-fail grading, admission, registration, residence and dining facilities, the libraries, bookstore, and computer services.

The Forum also has the authority to review with recommendations to the board of trustees or other appropriate bodies, programs in long-range planning, such as academic development, staff requirements, physical facilities, and the over-all budget of the university; community relations programs; administrative appointments at the rank of dean and above; and matters pertaining to curriculum, research, and academic discipline.

The constitution of the Forum has been ratified by the board of trustees, which retains ultimate legal authority over all transactions of the university and its various constituent elements. Members of the board have demonstrated a positive and appreciative attitude toward the Forum from its experimental beginnings to the present.

All meetings of the Forum are open to the university community, with the right to address the Forum provided to any person desiring to do so. The Forum meets in the University Center. Its office in located in room C-203, University Center.

Honorary and Recognition Societies

Honorary scholarship societies at Lehigh include Phi Beta Kappa (the oldest national honorary society), Tau Beta Pi (national honorary engineering society organized at Lehigh in 1885), Sigma Xi (pure and applied science), Beta Gamma Sigma (business administration), and Phi Eta Sigma (freshman honorary). There are about two dozen other national honorary and recognition societies. These recognize service or achievement in different fields of study as well as leadership.

Volunteer services

Varied opportunities for student expression of social responsibility exist through programs sponsored by the Lehigh University Volunteers (LUV). More than 300 Lehigh students participate in volunteer service efforts in the Lehigh Valley area in a range of service programs. LUV is governed by a board composed of coordinators of its various projects.

Most of the volunteer work is done in cooperation with community agencies or schools. Some of the projects include tutorial and teaching aide programs in public and private schools, recreation activities through the YMCA and neighborhood centers, Big Brothers, companionship and group work with children and adults in residential mental health treatment facilities, aid to the elderly in institutions and at home, income tax service at neighborhood centers, blood assurance, and numerous individual and short-term efforts.

LUV is located in room 202, University Center.

Student organizations

At Lehigh, student organizations embrace a wide range of activities. Course societies promote intellectual interests in various fields of study and develop professional spirit among the students. Interest and hobby groups include art, bridge, chess, camera, computer, languages, sailing, skiing, boxing, judo, political clubs, and fencing.

Religious activities

The religious program is under the general supervision of the university chaplain, who also provides for Protestant chapel services, broadly based and ecumenical in form, varying from the traditional to the informal and innovative. Some services feature the Lehigh University Glee Club while others utilize folk music. Roman Catholic masses are arranged by the chaplain for Catholic students.

The regular Protestant and Roman Catholic service schedules are announced at the beginning of the year. Attendance at all religious services is voluntary. The university is nondenominational.

The Chaplain's Council, consisting of representatives from the various religious groups of all faiths on campus, sponsors a variety of programs together with those organizations and separately under the chaplain's office. The council has sponsored, for example, a luncheon program and a film series, both with discussion, talks by religious leaders and faculty members, and multi-media presentations. Council programs are open to all students.

The Newman Association carries on a program among Catholic students under the guidance of two priests assigned by the Diocese of Allentown to direct the program. The association recently acquired a former private residence on campus for use as a Newman Center. The facility will be operational in fall, 1977. All members of the university community are invited to participate in the association's activities.

The Hillel Foundation program is available to students of the Jewish faith, while various Protestant churches in the community include fellowship organizations for Lehigh students in their programs.

Athletics

The university's intercollegiate program consists of varsity teams in baseball, basketball, cross-country, football, golf, hockey, lacrosse, rifle, soccer, swimming, tennis, track and wrestling; junior varsity teams in baseball, basketball, football and wrestling; and freshman teams in most of these sports.

Schedules are arranged chiefly with eastern colleges which have athletic policies similar to Lehigh's. Seven varsity sports are available for women.

Normally Lehigh's athletic schedule includes five or six home football games, eight or nine home wrestling meets, nine or ten home basketball games, nine home baseball games and home games in all other sports in which the university competes.

A comprehensive intramural sports program is sponsored for the entire university, including teams from the residence halls, fraternities and sororities, classes, town, faculty, graduate students, and independent groups. Twenty-four sports acitivities are included in the program. Students are encouraged to participate in these recreational sports, and awards are given for group and individual excellence.

Music

Lehigh sponsors both a variety of student organizations, which give performances on the campus and away, and a professional concert series, Music at Lehigh, which brings visiting artists to the campus. The choruses, bands, orchestra and ensembles are conducted by members of the music faculty and managed by elected student leaders.

Christmas Vespers and Spring Vespers are traditional choral performances. Recent audiences have heard the Mozart *Requiem*, the Schutz *Christmas Story*, the Benjamin Britten *St. Nicolas* and *Ceremony of Carols* and the Stravinsky-Cocteau opera-oratorio *Oedipus Rex*. The Glee Club has toured in England, Ireland, Wales and the Caribbean area, and has sung with the choirs of Mt. Holyoke, Smith, Wellesley and other women's colleges.

The Concert Band regularly plays at the Winter Band and Pops Concerts. A recent season included a retrospect of music by Bennington College composer Henry Brant. The Concert Band has performed in Canada, in Washington, D.C., and on the campuses of other colleges and universities.

Performances by the String Orchestra and the Ensembles traditionally close the semester concert season. The ensembles include groups of string, brass, woodwind, percussion and mixed instruments. Recent additions have been ensembles of Renaissance instruments from the university collection.

The Marching Band is widely known for its imaginative, student-conceived precision drills and its spirited performances on the field in support of the Lehigh football team. Ninety-seven men and women are members of this fine unit.

The concert series, Music at Lehigh, presents a variety of concerts and recitals. Some of the artists who have appeared recently are the Goldovsky Opera Company, The Philadelphia Composers Forum, the Cincinnati Early Music Consort, the Mostovoy Soloists and the Nu Liberation Art Unit.

A variety of musical artists are presented by the Student Activities Council. Lehigh students receive further exposure to music through bands hired by individual living groups to perform for weekend parties. "Band parties" are a staple of the Lehigh social menu.

Drama

The Lehigh University dramatic society, Mustard and Cheese, operates in conjunction with the division of speech and drama. Theatrical productions vary from the avant garde to musical comedy.

Membership is open to all Lehigh students and is extracurricular.

Opportunities exist for both onstage and backstage participation.

Guest speakers

The university affords its students the opportunity to hear a wide variety of notable speakers throughout the year. Students are welcome to attend speeches free of charge. In addition to the speakers who are nationally known, the university presents scholars in many disciplines on a regular basis.

Among outstanding speakers brought to the Lehigh campus during a recent period were U.S. Sen. Richard S. Schweiker (R-Pa.), consumer advocate Ralph Nader, women's rights activist Florynce Kennedy, labor columnist Victor Riesel, scientist Rollo May, Dr. Timothy Leary, anthropologist Margaret Mead, writer Jimmy Breslin and writer William Rusher. These speakers have appeared under the auspices of the Visiting Lecturers Committee.

The Jacob Blaustein lecture series in international relations brings famous figures to Lehigh. Lecturers have included former U.S. secretaries of state Dean Rusk and George W. Ball, General Maxwell D. Taylor, Belgium's Paul-Henri Spaak, Israel's Abba Eban, U.S. disarmament expert Averell Harriman, columnist James Reston, and former British prime minister Harold Wilson. The series was established through the gift of the Jacob and Hilda Blaustein Foundation. Mr. Blaustein, Class of 1913, was a pioneer in the petroleum industry and an international statesman.

The Berman Lecture Series in Economics has brought to the university John Kenneth Galbraith, the Harvard-based economist, and Marina von Neumann Whitman, the first woman ever to have served as a member of the Council of Economic Advisors. The series is sponsored by Mr. and Mrs. Philip I. Berman, noted retailers and philanthropists.

The Mellon Lectures feature speakers interested in the relationship between technology and the humanities. Three speakers are customarily sponsored during each academic year. The series is supported by a grant from the Andrew W. Mellon Foundation.

Exhibitions

The university presents a series of major exhibitions during the year in the Ralph L. Wilson Gallery in the Alumni Memorial Building and

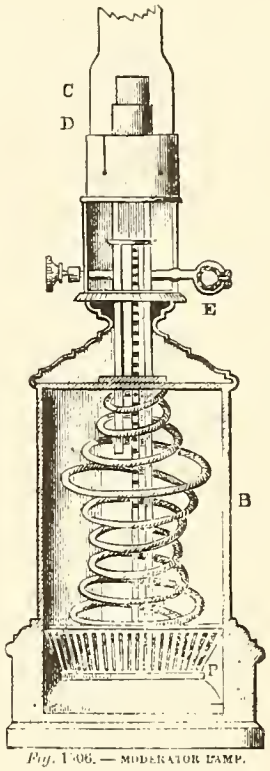

Fig. 1-06. — MODERATOR LAMP.

Fig. 1359. — ICHNEUMON, (*Pimpla persuasoria.*)

the DuBois Gallery in Maginnes Hall.

These exhibitions are designed to introduce students to well-known American contemporary artists as well as local artists in all conceivable expressions of art and related fields, with emphasis on technology and new approaches.

Since 1954, Ralph L. Wilson, Class of 1921, has sponsored an annual exhibition of contemporary American Paintings. This show focuses on the latest developments in the American art scene, bringing to the campus unknown promising artists, some of whom have later achieved deserved recognition.

The exhibitions in the last few years have included such shows as: Paolo Soleri, Puerto Rican Printmakers, Clare Romano and Michael Jacques, six French photographers, 3rd U.S. International Graphic Annual, Currier and Ives, and local artists. A number of exhibitions are traveling shows, such as American Figure Drawing '76, Shades of American Innovative Years (Wilson Collection), Arthur B. Davies (Lehigh collection), and Benton Sprnance.

An active gallery talk and lecture series brings artists whose works are being exhibited to discuss their work with students.

A new program, also offered as a course, has been established for restoration, curatorial work, and conservation. A conservation laboratory enables undergraduates to understand conservation and preservation of art.

Collections

The university has several major collections. The Grace Collection of Paintings (Reynolds, Romney, Gainsborough, Hobbema, Daubigny, Goya, Inness, etc.) is the most significant. Others are the Dreyfus Collection of French Paintings (Sisley, Fantin-Latour, Bonnard, Vuillard, Signac, Redon, Courbet, Picasso); The Ralph L. Wilson Collection of American Art Paintings (Prendergast, Sloan, Henri, Luks, Lawson, Bellows, Beal, Glaskens, Hartley, Marin, Burchfield, Zorach, Bouche, Graves, Koch); prints (Whistler, Feininger, Hassam, Taylor-Arms, Pennell, Benton, Kent, Motherwell, Johns, Hayter, Oldenburg, Warhol); The Prasse Collection of Prints (Delacroix, Matisse, Renoir, Blampied, etc.); Isaac Collection of Prints and Paintings (Early American prints of the local area); George and Viola Fearnside Collection (Old Masters drawings and prints); Harry Meyers Collection of Paintings (Sully, Gainsborough); Baker Collection of Chinese Porcelains (Ming, K'ang, Hsi, Ch'ien, Lung, Tang); and The Philip and Muriel Berman Collection of Japanese Prints (Utamaro, Inove, Kotozuka, Onchi).

The Lehigh University permanent collection is viewed as one of the best small private college collections in the East.

Publications/Radio

The students produce a semiweekly newspaper, the *Brown and White*, and a yearbook, *The Epitome*. The students' radio stations, WLRN, 640 kc., and WLVR-FM, 91.3 MH_Z, both broadcast throughout the day. Students also operate their own television station, WLTN, Channel 2.

Coffeehouse

A student-operated coffeehouse which seats about fifty persons is located in the undercroft of Packer Memorial Church. It is known as the Catacombs.

Hotlines

The university has two hotlines for the benefit of students and others. The sports hotline is (area code 215) 691-1885. The Lehigh University Social Hotline is (215) 868-8668.

REGULATIONS OF THE UNIVERSITY

ACADEMIC RULES

The following information concerning academic and other requirements and regulations should be of special interest to all students enrolled at the university or those planning to seek admission.

Eligibility for degree

In order to be graduated, a candidate for a baccalaureate degree must achieve a minimum cumulative average of 1.7.

To be eligible for a degree, a student must not only have completed all of the scholastic requirements for the degree, but also must have paid all university fees, and in addition all bills for the rental of rooms in the residence halls, or for damage to university property or equipment, or for any other indebtedness for scholarship loans or for loans from trust funds administered by the university.

Responsibility for meeting requirements

A student is responsible for consulting with his or her academic adviser or department chairman, prior to the senior year, to ascertain his or her scholastic eligibility for the degree for which he or she desires to qualify and to determine that the student will meet all program and hours requirements.

Final date for completion of requirements

For graduation all requirements, scholastic and financial, must have been satisfied prior to the graduation exercises.

Notice of candidacy for degree

Candidates for graduation on University Day in May or June file with the registrar on or before March 1 a written notice of candidacy for the degree; candidates for graduation in January file a notice of candidacy on or before December 1; candidates for graduation on Founder's Day, the second Sunday in October, file a notice of candidacy on or before September 1. Failure to file such notice by the dates mentioned debars the candidate from receiving the degree at the ensuing graduation exercises. If a petition for late filing is granted, a fee of $10 is assessed.

Graduating theses

Undergraduate theses, when required, are accompanied by drawings and diagrams, whenever the subjects need such illustration. The originals are kept by the university, as a part of the student's record, for future reference; but copies may be retained by students and may be published, provided permission has first been obtained from the faculty.

Credit and grades

A semester hour of college work consists of one hour a week of lectures or classwork, or two or three hours of laboratory work per week (or laboratory work combined with classwork) for one semester. The normal assumption is that the student will be expected to do at least two hours of study in preparation for each hour of classwork.

Latest date for registration. No registration is accepted later than the tenth day of instruction in any semester.

Grading system. Final grades in courses are A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F. The key to grades is as follows: A—excellent; B—good; C—continuation competency, defined to mean that the student has achieved a level of proficiency such that the instructor believes that he or she is prepared to take any subsequent course which has this course as a prerequisite; D—unsatisfactory, but passing, defined to mean that the student has achieved a level of proficiency such that he can apply the course toward graduation, but in the estimate of the teacher he or she has not acquired adequate proficiency to perform satisfactorily in any subsequent course which has this course as a prerequisite; F—failure. Courses taken under the Pass-Fail system are graded P (passing) or F (failure).

A student who withdraws from a course during the first nine weeks of instruction will receive a grade of "W". All students who withdraw from a course after the above date will receive "WF" unless the committee on standing of students, for cause, allows a grade of "W" to be recorded.

A student officially withdrawn from the university after the above dates receives from each instructor a "WP" or "WF".

"Abs." (absent) indicates absence from a final examination in a course. The grade of "Abs." is reported with a letter grade in parentheses, such letter grade representing the department's estimate of the student's work up to the close of instruction with the provision that in cases where a department does not feel justified in reporting an estimated grade, a report of "Abs. (X)" will be returned.

"Inc." indicates that the work in a course is incomplete. In such cases, an appropriate letter grade accompanies the "Inc." designation (e.g., "Inc.[B]") if the instructor has sufficient basis to report such a grade. Otherwise, the grade shall be reported as "Inc.(X)." A student who incurs an "incomplete" in any course and fails to remove the "incomplete" within one calendar year, loses all equity in the course.

Pass-fail system. The pass-fail grading option is intended to encourage student exploration of challenging courses that would normally be avoided for fear of depressing grade-point averages. It is intended particularly for exploration outside the major field.

Students should avoid wasting this option on unsuitable courses, such as certain basic introductory courses having no college-level prerequisite or corequisite.

Students who desire to take particular courses pass-fail shall consult (at the time of preregistration) with their curriculum directors or registration advisers for guidance in this area. Each curriculum director or registration adviser should consider the intent of this system and the demands of the particular curriculum, then formulate suitable guidelines to aid students in the intelligent use of this option. At the same time, instructors should be prepared to advise particular students as to the suitability of the particular courses for the pass-fail option.

The restrictions on the use of the system are:

1. Before a student can take a course pass-fail, he or she must have achieved sophomore standing, have declared a major, and be in good academic standing.
2. A student may take no more than two courses pass-fail in any one semester. He or she may take a maximum of six courses pass-fail per undergraduate career if engaged in a four-year program or a maximum of eight courses per undergraduate career if participating in a five-year, two-degree program.
3. No course may be taken pass-fail that satisfies any part of the graduation requirements for the major.
4. A student must have the registration adviser's approval to take a course pass-fail. A student must designate the course(s) taken pass-fail by the tenth day of instruction in a regular semester or the fifth day of instruction in any summer term. Prior to this deadline, the student may transfer from pass-fail grading to regular grading or vice versa without penalty. After this deadline, the student cannot transfer from regular grading to pass-fail grading or vice versa.
5. The instructor giving the course is not officially notified which of the students is taking the course pass-fail. Therefore, he or she reports a regular letter grade for the pass-fail students. The registrar then records "P" for reported letter grades of A, B, C and D including + or - and "F" for a reported letter grade of F.
6. Under this system, the student does not receive the letter grades of A, B, C or D if he or she passes the course. A passing grade applies to the student's graduation requirements but is not used in the computation of the cumulative average. An F grade is computed in the normal manner.

Grade values and probation

The scholastic requirements for each student are expressed in terms of a cumulative scholastic average, which is the weighted point average of all grades received while in residence.

The cumulative scholastic average will be computed at the end of each semester (and full summer session, i.e., one in which twelve or more semester hours have been rostered). Grades are weighted as follows: A=4, A-=3.7, B+=3.3, B=3, B-=2.7, C+=2.3, C=2.0, C-=1.7, D+=1.3, D=1.0, D-=0.7, F=0.0. WF, Abs. (F), Inc. (F), 0.

If a course in which a D+ or lower grade was received is repeated, the grade received upon repetition of the course shall be counted in the cumulative average, and the grade(s)

and credit hours received when the course was previously taken will be dropped from the cumulative average.

W, WP, Abs. (X), and Inc. (X) grades are not included in averages. WF is counted as an F. When grades of "absent" or "incomplete" include a letter designation, this letter is used in determining the average.

Probation. A student is placed on scholastic probation when either:
(a) The individual's cumulative scholastic average falls below these levels:
freshman, first semester 1.30
freshman, second semester 1.40
sophomore, first semester 1.50
sophomore, second semester 1.60
junior, first semester and thereafter 1.70
(b) The person fails more than seven semester hours in one semester.

The designation "freshman, first semester," etc., is the classification officially determined by the registrar irrespective of the number of semesters the student has attended college.

Disabilities of scholastic probationers. A student who is on scholastic probation is ineligible for (a) intercollegiate competition and all other activities publicly representative of the university, (b) major office, elective or appointive, in any university organization, and (c) such other activity as may require more time than should be diverted from primary purposes by any student whose academic survival is at risk.

All students, however, have the right to petition to the committee on standing of students for exceptions.

Removal from probation. A student who has been placed on scholastic probation is restored to good standing if at the end of the next semester or full summer session all incompletes incurred during the previous semester have been removed and if the student meets the standards indicated.

Dropped for poor scholarship. A student who makes a 2.20 average or better in his probationary semester but fails to meet the standards for cumulative scholastic average is continued on scholastic probation for another semester. A student who makes less than a 2.20 average in the probationary semester and fails to meet these standards will be dropped for poor scholarship.

Honors opportunities

There are three kinds of honors, namely: class honors, graduation honors and departmental honors. Further information on special academic opportunities is provided in the color section which follows.

Class honors. Upon completion of the work of the freshman and sophomore years, on recommendation of the registrar and by vote of the faculty, class honors are awarded to those individuals who have made an average of 3.00 or better during the preceding academic year.

The names of these students are announced at the Founder's Day exercises on the second Sunday in October and are printed in the program.

Graduation honors. Degrees "with honors" are awarded by vote of the university faculty to those students who have attained an average of not less than 3.25 in their junior and senior years' work at the university.

Degrees "with high honors" are awarded by vote of the university faculty to those students who have an average of not less than 3.50 in their junior and senior years' work at the university.

Degrees "with highest honors" are awarded by vote of the university faculty to those students who have an average of not less than 3.75 in their junior and senior years' work at the university.

Students who spend all or part of their junior or senior years at another institution may qualify for graduation honors under the following conditions:

1. The student must have at least ninety hours or work at Lehigh and an average during the last four semesters in residence at Lehigh which qualified him or her for graduation honors. This average determines the highest category of graduation honors that is possible for the student to attain.

2. The student's average at the other institution when computed with the last four semesters at Lehigh must be such as to still qualify the student for graduation honors. This average may lower the over-all average of the student from one category of graduation honors to another one.

Graduation honors are announced on University Day at the end of the spring semester and are published in the commencement program.

In all cases, it is required that each student have not less than forty-eight hours of work graded A, B, C, D, or F, including + or - designators.

In computing the averages of candidates for graduation honors, semester grades are weighted according to the number of credit hours in the course concerned.

Fig. 377. — BLUE-FISH, (*T. salvator.*)

Review-Consultation-Study period

The Review-Consultation-Study (RCS) period is intended to provide a few days for informal academic work between the end of the formal instruction period and the beginning of the final examinations.

It is expected that students will use this period to consolidate their command of the material in their courses. Faculty members make themselves available to their students at announced times during the period; for example, at the hours when they meet classes during the formal instruction period. No quiz may be given during the eight-day period before examinations.

GOOD CITIZENSHIP

Lehigh University exists for the transmission of knowledge, the pursuit of truth, the development of students, and the general well-being of society. Free inquiry and free expression are indispensable to the attainment of these goals. All members of the academic community are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth.

Out of concern for individuality and res-

pect for the privacy of all persons, the university does not impose a common morality on its members. Institutional existence, however, is a privilege granted by public trust, subject to the sanctions and responsibilities defined by the society of which Lehigh University is a part.

Furthermore, society generally provides legal canons, ethical mores, and conduct expectancies pertaining to individual and collective behavior. Thus, the university has the obligation to establish standards of conduct appropriate and applicable to the university community.

Lehigh accepts its responsibility as an institution within the broader social community. The standards of behavior expected of its members are those which the university regards as essential to its educational objectives and to community living.

In accordance with these purposes and objectives, disciplinary action will be taken when necessary to protect the academic integrity of the university and the welfare of its members. An emphasis on counseling and learning will accompany such action.

All members of the university community are subject to municipal, state and federal laws. Obviously the university cannot be a sanctuary for persons who violate these laws. Lehigh is concerned, however, about the rights of students as citizens (with equal protection under the law) and will direct them to legal counsel when necessary.

For just cause (relating to the educational purposes of the university) Lehigh reserves the right to review actions taken by civil authorities against its members. Although ordinarily Lehigh will not impose additional sanctions after criminal disposition of a case, it does have the obligation to introduce counseling and/or disciplinary action if the person's conduct has interfered with the university's exercise of its educational objectives or responsibilities to its members.

Further, the university as a part of the community has an obligation to report serious crimes to the appropriate civil authorities.

Lehigh relies primarily on general principles and statements of expectation for the guidance of conduct, and assumes that those admitted to the university community are capable of governing themselves accordingly. Specific regulations are kept to a reasonable minimum and are published in the *Lehigh Handbook*. These regulations govern academic honesty and social conduct (including drugs, alcoholic beverages, motor vehicles, etc.). Copies of the *Lehigh Handbook* are made available to every student. Students are responsible for knowing the procedures, rules and regulations as published in the *Handbook*. Freshman residential students should note that permission is *not* granted to them to have motor vehicles on the campus.

Violations of the student conduct code are adjudicated by the committee on discipline which operates under the principles of due process.

DISSENT

Regarding dissent, the university faculty has a policy which emphasizes the responsibility of all members of the university community.

Fig. 376. — BLUE-BOTTLE, OR FLESH-FLY. (Magnified.)

The guidelines adopted broadly set forth acceptable forms of dissent on campus.

Generally, the policy on dissent provides the following:

1. Free inquiry and free expression, including the right to open dissent, are indispensable in achieving the goals of an academic community.

2. Coercive activities employed by individuals or groups either to repress legitimate dissent or to demonstrate dissent are a threat to the openness of the academic community and will be dealt with as an extremely serious matter.

3. Where physical coercion is employed or physical obstruction persists and the university is prevented from resolving the matter through its established disciplinary procedures, legal sanctions will be employed.

This statement provides that orderly and peaceful demonstrations on campus are not forbidden unless they interfere with legitimate university function. The authority for making the initial judgment in determining the permissible limits of protest rests with the president and counsel of an advisory committee consisting of four faculty members and four students.

Conduct which exceeds permissible limits will be met with university sanctions ranging in severity from admonition to expulsion, or in cases of aggravated or persistent violation of defined rights, with civil arrest and prosecution under an appropriate charge. Prime authority for discipline rests with the faculty and its committee on discipline.

SPECIAL ACADEMIC OPPORTUNITIES

AN INTERDISCIPLINARY TRADITION

Lehigh has traditionally taken advantage of its relatively small size and lack of rigid departmental lines to develop flexible and interdisciplinary programs.

On the graduate level, a student may choose to pursue work by field rather than department in such areas as computer science, applied mathematics, management science and molecular biology. The graduate student also may do a thesis or dissertation research in one of the eight interdisciplinary centers, which are described in the special section starting on page 54.

Interdisciplinary work on the undergraduate level can be arranged in each of the colleges for the student desiring a concentration in a field outside a usual major.

The program in urban studies, outlined under Government on page 130, is intended to provide undergraduate instruction for students who wish to enter professional careers that require interdisciplinary knowledge of the problems of urban life or who will be pursuing graduate studies in urban affairs. Several cooperating departments, associated with the Center for Marine and Environmental Studies, provide instruction in marine ecology, biological oceanography, sanitary microbiology, water supply and transport, and environmental planning.

Because environmental studies are interdisciplinary in nature, the emphasis in these courses is to provide a general introduction to the undergraduate planning graduate study in a specialized area.

STUDENT OPPORTUNITIES

Freshman Seminars

Interdisciplinary problem-centered Freshman Seminars (FS) are offered each semester to freshmen enrolled in any curriculum.

A three-credit-hour seminar will serve as a general studies option in the engineering and physical sciences curriculum, a preliminary distribution elective in the arts and science curriculum, or an arts option or free elective in the business and economics curriculum.

Freshman Seminars have been selected from those proposed by professors who have specified a transdisciplinary inquiry which they would like to pursue in seminar fashion with a group limited to fifteen freshmen. Such study gives each student experience in relating contemporary cultural problems to the many disciplines in the humanities and sciences. It also provides an opportunity to make initial exploration of one or more of those disciplines, thereby helping to season the student's judgment as to how his or her university education could best be structured.

Freshmen interested in enrolling in a Freshman Seminar are invited to use the application form that is part of the Freshman Seminar Announcement each semester, and which accompanies preregistration materials. After consultation with their faculty advisers, students submit these applications with other preregistration materials. The class roster for each Freshman Seminar is made up of students from each of the colleges. Beyond that basic restriction, selection of students is made by random choice from among the applicants. Those who apply but are not chosen in the fall semester are given priority should they apply again in the spring semester.

Typical Freshman Seminars offered in recent semesters include: The Future of American Politics; Cultural Transition: Its Nature and Forms; Games and Play; Images of Self and Reality; Africa: Sleeping Giant?; American Literature and the Visual Arts; Visual Sociology.

High Immediate Relevance Courses

A program of High Immediate Relevance (HIR) courses enables all instructional departments to introduce courses temporarily within a semester. HIR courses are normally either experimental courses or courses based on contemporary social and scientific issues. They may later become part of the regular curriculum if proven successful.

HIR courses can be taken on a pass/fail basis. Since most HIR courses are not developed in time to be included in course listings, they are identified with a 97-98 number and are incorporated in the registrar's official semester roster for a maximum of two semesters.

A sample listing of High Immediate Relevance courses includes: The American Presidency; Present and Future Energy for the World; The Black in American Literature; Electronic Music; Oral History; Contemporary Issues in Soviet Politics; Clinical Applications of Psychological Principles; and Ideologies and World Politics.

Change of major

There is flexibility in undergraduate curricula at Lehigh, intended to take into consideration the changing interests and needs of students.

For example, in the College of Engineering and Physical Sciences, each department provides a range of hours needed for graduation to provide flexibility to the student who wants to take more or less work outside the department. This flexibility extends to late changes of major or even a change in college without loss of credits.

Graduate students may find their interests shifting to new fields as they progress in their educational program or they may wish to strengthen their preparation for a career by advanced study in a related field or in an interdisciplinary program. The policy of the Graduate School is to provide as much flexibility as possible to students who wish to change to a new but related field of study after either the baccalaureate or the master's degree.

Students should consult with the director of their previous program and with the director of the new field in which they are interested to establish the course program that will remedy any deficiencies in background and will be of maximum value.

Students who have just completed a bachelor's degree in one field at Lehigh University may find it advantageous to study for a graduate degree in a related field under a new group of the faculty without losing the continuity and familiarity provided by staying on the Lehigh campus.

Five-year, two-degree programs

Another feature of Lehigh's flexibility is the opportunity for five-year, two-degree programs which enable a student to receive either two bachelor degrees or a bachelor and a master's degree upon completion of five years of study.

Most five-year, two-degree programs appear in the description of courses under Arts-Engineering (page 69) and Five-Year Programs (page 120). It is possible to arrange for a dual bachelor degree program even after studying at Lehigh for some period of time. Engineering students, for example, who decide at any stage of study that they wish to meet the requirements for both the bachelor of arts and the bachelor of science degree may complete the combined requirements in five or possibly six years, depending on when they decide to try for both degrees.

Of increasing interest to undergraduates are the two-degree, five-year programs which enable one to secure a bachelor and a master's degree. Because Lehigh's well-established graduate programs are closely integrated with the undergraduate programs, it is possible to consider programs leading to the engineering-master of business administration degree, the arts-master of business administration degree, the engineering-master of science in materials program, or the fifth-year program in the School of Education which enables those receiving a bachelor of arts degree to accomplish professional teacher training and serve as salaried interns in the public schools. After the completion of one year of full-time teaching, students can receive the master of arts for secondary teachers or the master of education degree for elementary teachers.

Many other five-year, graduate-level combination programs exist, and students are advised to consult with their adviser in planning such programs.

Pre-law programs

Lehigh has a strong pre-law tradition. In keeping with the policy of the Association of American Law Schools, the university does not have any prescribed undergraduate pre-law program.

Lehigh students have been successful in attaining entrance into law schools from diverse curricula within all three of the undergraduate colleges.

An active student-run Pre-Law Society brings members of the legal profession and law school personnel on campus for discussion meetings, and continuously provides information about law school opportunities.

Law-related courses, some of which rely on the casebook method, are provided by both

Fig. 1356. — AN ICEBERG.

the College of Arts and Science and the College of Business and Economics. Counseling is available to prospective pre-law students on a continuous basis from freshman orientation through the law school application process in the senior year through members of the pre-law advisory committee, composed of faculty members of both colleges. Students are urged to consult members of the committee as early as possible in their academic careers.

Details on a law and legal institutions minor program will be found on page 33.

Health professions programs

Schools of medicine, dentistry and veterinary medicine stress the importance of a broad general education as well as prescribed studies in the sciences. As long as candidates have the essential courses in biology, chemistry, physics, and mathematics, they may major in any of the three undergraduate colleges.

A health professions advisory committee, which includes faculty members from biology, chemistry, engineering and physics, provides information during freshman orientation to interested students and actively works with health-professions candidates from the sophomore year on to assist them in planning for entrance into professional schools in conjunction with their major advisers.

Lehigh affords two special baccalaureate-doctor of medicine degree programs for students interested in becoming physicians. These limited-enrollment programs are offered in association with two Philadelphia-based medical schools.

A bachelor of arts program in premedical science or a bachelor of science program in chemistry are available in connection with Hahnemann Medical College. A bachelor of arts in premedical science program is associated with the Medical College of Pennsylvania. Descriptions of these accelerated courses of study may be found below.

Students interested in optometry, pharmacy, podiatry and other allied health fields may obtain information from the health professions advisory committee in planning their courses with their academic advisers.

Among the health professions programs offered at Lehigh are two introduced during 1975 which provide for accelerated education leading to both the baccalaureate and doctor of medicine degrees within a total of six years of study. A limited number of exceptionally well-qualified students are accepted for these special programs.

Lehigh-Hahnemann M.D. program

Lehigh University, in cooperation with Hahnemann Medical College and Hospital in Philadelphia, offers an accelerated six-year program leading to a combined baccalaureate degree and a doctor of medicine degree with an emphasis on family medicine. The program is designed to increase the number of primary health care physicians in the Lehigh Valley and in eastern Pennsylvania by giving special preference to well-qualified students from these areas with a strong inclination toward family-practice medicine.

Two curricula are offered to Lehigh students who desire to be considered as candidates for the Hahnemann program: a premedical science and a chemistry major. In both programs the student spends two academic years and two summers at Lehigh completing courses, which differ somewhat depending on the major chosen and total approximately ninety semester hours. The curricula followed meet the biology, chemistry, physics and mathematics prerequisites required for medical admission and allows some flexibility in the selection of elective courses.

A joint Lehigh-Hahnemann selection committee will, in the student's second year of residence at Lehigh, select up to ten of the candidates based on academic achievement, maturity, and a sincere desire for family-practice medicine, and recommends these students to Hahnemann Medical College. It should be emphasized that admission to Lehigh as a candidate in this Lehigh-Hahnemann program does not imply automatic admission to Hahnemann Medical College. Those of the group who choose not to continue or who are not admitted to Hahnemann at the end of the two-year curriculum still may continue in the traditional premedical program, may select other health profession fields, or may complete a biology, chemistry or alternate degree.

The chemistry major sequence in this accelerated medical education program requires an advanced placement exemption from general chemistry *or* the completion of this course in the summer before the freshman year. Because of this requirement for advanced standing it is possible for a student, should he or she not continue into Hahnemann at the end of two years of study, to complete a bachelor of science in chemistry in one more year. The student is then at liberty to apply for regular medical school admission or to pursue graduate work in chemistry.

Students selected to enter Hahnemann spend their third academic year (first medical year) in the basic sciences core curriculum, including anatomy, biochemistry, physiology, microbiology, pharmacology, pathology, clinical science and behavioral problems.

The fourth year in the joint program is spent in clinical rotations through which students learn the elements of clinical medicine through intensive clerkships in each of the major divisions of medical practice: medicine, surgery, obstetrics and gynecology, psychiatry, and pediatrics.

The fifth year is an advanced clinical basic science exposure in which intensive correlative study applies the fundamental scientific principles to clinical medicine.

The sixth and final year is conducted totally in the Lehigh Valley area utilizing local physicians and local medical facilities and further acquaints the student with the challenges of family-practice medicine. The program results in the awarding of a doctor of medicine from Hahnemann Medical College and a bachelor's degree (in either premedical science or chemistry) from Lehigh University.

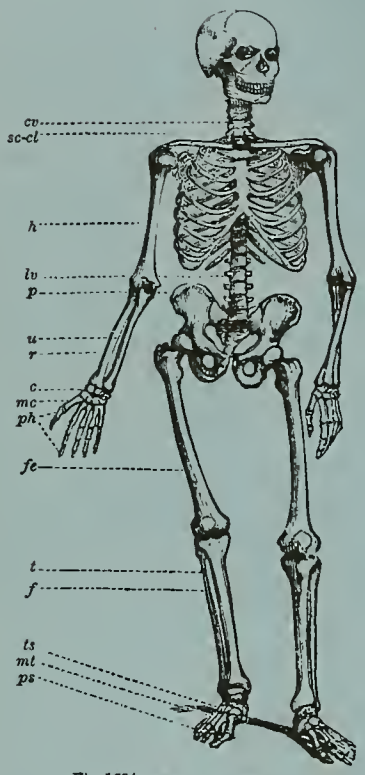

Fig. 1694. — SKELETON OF MAN.

Bachelor of arts in premedical science

The suggested sequence for the bachelor of arts in premedical science is as follows:

year 1: Lehigh University (two semesters)

Chem 21-22 (5)
Math 21 (4)
Engl (3)
elective (Humanities) (3)
elective (Social Science) (3)
Biol 21-22 (4)
Math 22 (4)
Engl (3)
Hist 8 (Social Science) (3)
elective (Humanities) (3)

summer 1: Lehigh University

Chem 51-53 (organic) (4)
Chem 52-54 (organic) (5)
elective (Humanities) (3)

year 2: Lehigh University (two semesters)

Phys 11-12 (5)
Math 23 (4)
elective (Biology) (3)
elective (Humanities) (3)
elective (Social Science) (3)
Phys 13-14 (4)
Chem 194 (physical) (3)
Biol 28 (genetics) (3)
elective (Humanities) (3)
elective (Humanities) (3)
elective (Social Science) (3)

summer 2: Lehigh University

elective (Social Science) (3)
elective (free) (3)

The student has completed ninety credit hours of work at Lehigh University upon completion of the summer 2 program.

Bachelor of science in chemistry

The suggested sequences for the bachelor of science in chemistry are as follows:

year 1: Lehigh University (two semesters)

Phys 11, 12 (5)
Math 21 (4)
English 1 (3)
Biol 21, 22 (4)
Hist 8 (3)
Econ 1 (4)
Math 22 (4)
English 2, 10, 14 or 16 (3)
Chem 31 (3)

summer 1: Lehigh University

Chem 51, 54 (4)
elective (3)
Chem 52 (3)
Math 23 (4)

year 2: Lehigh University (two semesters)

Phys 21, 22 (5)
Chem 358 (3)
Biol 28 (3)
General Studies requirement (6)
Chem 194 (3)
Chem 188 (2)
Chem 54 (2)
biology elective (3)
electives (6)

summer 2: (for those selected for medical school admission)*

Chem 332 (3)
Chem 234 (1)
Chem 371 (3)

summer 2: (for others continuing at Lehigh towards a bachelor of science in chemistry)

Chem 332 (3)
Chem 234 (1)
Chem 191 (3)

year 3: (for those continuing at Lehigh)

Chem 381 (3)
Govt 1 (3)
electives (12)
Chem 307 (3)
Chem 383 (4)
German 2 (3)
electives (6)

*During the internship, two additional three-credit chemistry courses are taken at Lehigh.

Lehigh-Medical College of Pennsylvania program

In cooperation with the Medical College of Pennsylvania, Lehigh offers an accelerated six-year program which enables selected students to earn both the bachelor of arts degree in premedical science and the M.D. degree after a minimum of six years of study at the two institutions. The program was initiated in the fall of 1974, and approximately fifteen students are admitted each year.

The program as outlined below shows two academic years and two summers at Lehigh, during which time ninety hours of credit are earned toward the 120 required for the baccalaureate degree. Students entering Lehigh with sufficient advanced placement credit may possibly minimize or eliminate the second summer session. The next four years are spent in the regular program of medical education at the medical college. After the first two years at the medical college students will have acquired the necessary additional credit hours for the baccalaureate degree.

During the first two years at Lehigh, students are expected to make satisfactory progress in the academic areas as well as in the more subtle task of personal growth in those attributes untimately needed as a physician. Seminars are conducted on campus by Medical College of Pennsylvania faculty, and students are assigned to MCP faculty advisers. MCP receives student grades and monitors student progress through regular counseling sessions and feedback from Lehigh staff.

MCP has specifically avoided setting arbitrary standards for performance in order to encourage students to pursue the more difficult courses and to range into new academic and extracurricular areas appropriate to the student's academic and personal growth.

The medical college reserves the right to withdraw an offer of acceptance if academic or personal concerns cause the college to question a student's ability to function as a physician. The college also reserves the right to require that a student spend additional time at Lehigh if the medical college feels that this is necessary for the student's academic or personal maturation.

Experience with the program to date indicates that such action is rarely necessary. In addition, the student may elect to take additional time at Lehigh prior to matriculation at the medical college if he or she feels that this would be beneficial. Should this occur, the student would be eligible to defer matriculation at medical school for a period of time agreed to by the student and the medical college.

Application for admission to the program must be made through Lehigh's office of admission. Admission is based on SAT scores (minimum combined score of approximately 1300), scholastic achievement, maturity, and motivation for medicine. Preference is given to residents of Pennsylvania.

Interviews are not required at Lehigh, but students are encouraged to make arrangements to come to campus to have an interview and to become better acquainted with Lehigh and the special features of the program.

year 1: Lehigh University

Chem 21-22 (5)
Math 21 (4)
Engl (3)
elective (Humanities) (3)
elective (Social Science) (3)
Bio 21-22 (4)
Math 22 (4)
Engl (3)
elective (Humanities) (3)
elective (Social Science) (3)

summer 1: Lehigh University

Chem 51-53 (organic) (4)
Chem 52-54 (organic) (5)
elective (Humanities) (3)

year 2: Lehigh University

Phys 11-12 (5)
Math 23 (4)
elective (Biology) (3)
elective (Humanities) (3)
elective (Social Science) (3)
Phys 13-14 (4)
Chem 194 (physical) (3)
Biol 28 (genetics) (3)
elective (Humanities) (3)
elective (Humanities) (3)
elective (Social Science) (3)

summer 2: Lehigh University

elective (Social Science) (3)
elective (free) (3)

Research initiates

Undergraduate students who seek or are considering a career involving research are encouraged to investigate the possibility of becoming research initiates in their junior or senior years.

Research initiates are attached to specific research projects in progress on the campus, serving as assistants to advanced graduate students or to staff members. They assist in experiments, sit in on project conferences, and if occasion permits, undertake small side investigations appropriate to their competence.

The research initiate may receive degree credit by registering for unrostered work for up to six hours per semester. In a few cases, a nominal stipend may be paid for the work, and summer employment is occasionally available. The student should explore the possibility of becoming a research initiate with the curriculum adviser.

Accelerated programs

It is possible for Lehigh students to accelerate their programs so that they may graduate in as little as three years. Such programs are made possible by credits awarded for advanced standing upon admission, credit by examination, overloads, and summer work. Again, interested students should consult with their curriculum advisers.

Special summer opportunities

In addition to the normal opportunities offered to graduate and undergraduate students in summer school, there are also opportunities for both remedial and accelerated work.

Special programs and field work activities are available for intense in-depth educational experiences. Examples of these include the Robert A. Taft Institute of Government, Field Study in Geology (conducted in Wyoming and Idaho) and the Civil Engineering Survey Field Course (conducted in the Pocono Mountains). Short courses and workshops are offered in a wide variety of subject areas.

Interested students should consult with their curriculum director or the director of summer sessions. A summer session publication listing the total summer program is available every spring.

Apprentice teaching

Apprentice teaching is designed for advanced students, normally in their senior year, who wish to learn about teaching under the guidance of an experienced teacher.

Master and apprentice teachers are, with the approval of the chairman of the department in which the apprentice teaching is done, free for the most part to work out whatever arrangements best fit the needs of the course.

Apprentices typically receive three hours of credit for attending all classes, doing some lecturing or leading of discussion sections, assisting in making up and grading some written assignments and tests, and being available for some individual consultation with students.

A student may register for apprentice teaching only once each semester, and only twice (for credit) in the college career, for a maximum total of six hours of credit. The student may be an apprentice teacher (for credit) in a given course only once. A graduate student who is not a paid teaching assistant may register for apprentice teaching, but the department must decide whether the credit received for the course will count toward fulfilling course requirements for a graduate degree. The apprentice will be graded by a master teacher.

Students who wish to do apprentice teaching in extradepartmental courses, such as those offered as Freshman Seminars, may do so with the approval of the director of the program. Such students will be registered for course number 300 in the appropriate program (e.g., F.S. 300; Apprentice Teaching in F.S. 97C). Course listings, however, simply list "300: Apprentice Teaching," with the course to be taught left unspecified.

Study in foreign countries

To the extent that their courses of study permit it, students maintaining a "B" average or better are encouraged to consider spending one or two semesters of study in acceptable "junior year abroad" programs or as regularly enrolled students in a foreign university.

Among the accepted programs are New York University in Spain, Smith College and Wayne State University in Germany, Sweet Briar College and Hamilton College in France, and Dickinson College at Bologna, Italy. Students declared qualified for acceptable foreign study remain eligible to apply for financial aid from Lehigh University.

To emphasize further its interest in international study, the university has provided funds to cover transportation, tuition, and living expense stipend for a graduating senior desiring to study abroad.

The university, through the department of modern foreign languages, offers four scholarships in the amount of $1,000 each for qualified students to study abroad.

The Harrisburg Urban Semester

Undergraduates from all parts of the university can spend either the fall term or the spring term in Pennsylvania's capital city of Harrisburg to study urban problems.

They live and work with students from other participating Pennsylvania colleges and are supervised by The Harrisburg Urban Semester (THUS) faculty or its member college faculty.

The curriculum consists of three basic parts: internship, independent study and an urban seminar. Internships, which are the core of the program, are available in federal, state, county, city, private and religious organizations. They range from environmental protection, prison and probation, drug rehabilitation, day care, state legislature, mental health, city planning, public works, legal services, and community organization.

Students in all fields of study are encouraged to participate. Upon completion of the semester, students receive sixteen semester hours of credit.

The Washington Semester

Opportunity is available each year for several selected juniors or seniors to spend one semester of study in the nation's capital through cooperation with American University in Washington, D.C., and some sixty other colleges and universities.

The students enroll at Lehigh but spend the semester in residence at American University with the students from the participating colleges.

Should a student withdraw from either the

Washington or Harrisburg program, the student will be held responsible for the costs incurred through the program. These costs will be calculated on the basis of the university's customary refund policy.

Afro-American studies

The university offers a number of courses that are relevant to Afro-American studies. Representative courses are Engl. 319, The Black in American Literature; Govt. 352, Civil Rights; Hist. 331, The Negro in America; S.R. 75, Minority Groups; and S.R. 320, Urban Ethnology. Students who are interested in Afro-American studies work out an interdisciplinary major with their advisers or with the dean of their college.

Cooperative college program

Lehigh University is a member of the Lehigh Valley Association of Independent Colleges (LVAIC). This consortium also includes Allentown College of St. Francis de Sales in Center Valley, Cedar Crest and Muhlenberg colleges in Allentown, Moravian College in Bethlehem, and Lafayette College in Easton.

Under an agreement among the colleges of LVAIC, students on one campus may cross-register for courses given on another campus. Students desiring to take advantage of this opportunity must obtain the consent of the course instructors and advisers concerned and accept differences in calendar and course scheduling. They must provide their own transportation.

A student taking a course on another campus under this arrangement does not pay extra tuition for the privilege, and the course he or she takes and the grade assigned in it are recorded on the transcript of the home institution. The agreement applies only to undergraduate students and extends to both the academic year and summer sessions.

A cooperative social welfare education program designed to provide preparation for entrance-level professional competence in social welfare positions is sponsored by LVAIC. Lehigh students wishing to participate in this program should consult with the chairman of the department of social relations.

Honors programs

The several honors programs are designed to permit students who demonstrate unusual academic ability and interest to explore more widely than their curricula would normally allow and to engage in independent study and research.

Departmental Honors

These programs give the University Scholar the opportunity to study in the major field more intensively and in greater depth than the standard program provides.

The precise nature of the program for each student is determined by the major department. The program may include:

a. Unscheduled work or independent study (up to four hours per semester in the junior year; up to six hours per semester in the senior year).

b. Waiver of graduate standing: undergraduate students will be permitted by petition to the Graduate School to register in a 400-level course for which they have the necessary prerequisites under the conditions that they: 1. have maintained a 3.00 average in each of the two semesters prior to the date of the petition, and 2. will carry a course load not to exceed fifteen hours unless four-credit courses, military science or aerospace studies and the like, raise it to seventeen hours maximum.

c. Honors thesis or project. Candidates for Departmental Honors must announce to their major adviser during the junior year, or no later than the beginning of the senior year, their intention to work for Departmental Honors. Each major adviser submits to the registrar, the dean of the college, and the chairman of honors programs, no later than the close of registration of each fall semester, the names of seniors who are working for Departmental Honors in the particular major.

The names of those students who attain Departmental Honors will be announced at the graduation exercises.

College Scholar Program in Arts and Science

The College Scholar Program offers the qualified student a unique opportunity for maximum enhancement of critical faculties, abilities and intellectual interests. This end is achieved through a structured program conforming to exceptional standards of breadth and rigor.

Undergraduate students in the College of Arts and Science may apply for acceptance into the program at any time during their college careers. An application is made to an honors committee, and acceptance is governed by the performance of the student to date and the committee's estimate of the likelihood that he or she will be able to fulfill the requirements of the program.

In order to be graduated with the designation "College Scholar," a student must fulfill the requirements and achieve a cumulative average of 3.50.

Each student is required to have an individually structured program which must be approved by the director. No course taken pass/fail may be used to satisfy the requirements. The requirements follow.

Area of concentration

The major. Departmental or interdepartmental. The academic level expected of candidates in the area of concentration can be attained by satisfactory completion of courses such as those at the 400 level, independent study, etc.

Thesis. The student takes a certain number of hours in independent study or thesis courses, culminating in a thesis or research report. This is read and rated by an ad hoc committee of three faculty, one of whom must be from outside the department or departments in which the student is doing major work.

Comprehensive. There is to be a comprehensive examination in the area of concentration; it may be written, oral or both. A committee in charge of the examination includes at least one person from a department other than that (or those) in which the student is doing major work.

Distribution requirements

English. English 1 and either 2, or 10, 14, 16.

Language. Proficiency in a classical or modern foreign language sufficient to complete the work of the fifth semester in any 3-3-3-3-3 language sequence; in a 5-5-4 sequence, completion of the third semester is required. There is no restriction on the languages acceptable.

Mathematics. One course from the following: Math. 21, 31 or 41.

Natural Science. Four courses chosen from two of the following areas: astronomy, biology, chemistry, geology, physics and psychology. At least one of these courses shall be in chemistry or physics, and at least one of the four courses shall include the accompanying laboratory course.

Social Science. Four courses chosen from the areas of archaeology, economics, government, history, international relations, psychology, social relations and urban studies. At least one of these courses must be in economics and one in history.

Humanities. Four courses chosen from the areas of drama, fine arts, literature (English and advanced courses in classical and modern foreign languages), music, philosophy and religion studies. At least one of these courses must be in philosophy or religion studies, one on literature, and one the creative arts (drama, music and fine arts).

Note: Each of the last three requirements is stated in terms of *areas*, not *departments*, in recognition of the fact that not all humanities courses are offered in the departments whose names appear under "Humanities," not all historical courses are offered by the history department, not all philosophy courses by the philosophy department, etc.

The committee makes the decision, in consultation with the appropriate departments, under which rubric a specific course may be counted. It also is empowered to admit what substitutions it deems wise.

Honors seminars

Two seminars, normally to be taken during the sophomore or junior year. A study of major ideas which have dominated Western thought.

Electives.

Humanities Perspectives on Technology program

The Humanities Perspectives on Technology (HPT) program is a broadly based effort on the part of Lehigh faculty, especially from the College of Arts and Science, to foster undergraduate courses conceived with the interrelationships between technological advance and the quality of human life.

The HPT program offers a minor in "Technology and Human Values," consisting of eighteen hours of course credit drawn from a

variety of departments. For a full description of the program see page 136.

Law and Legal Institutions minor

This program, based in the College of Arts and Science, is designed to foster interdisciplinary cooperation with the faculties of the other colleges in the university. This minor program is open to students from all three undergraduate colleges. Although the program may be of particular interest to some prelaw students, it is not intended to be viewed as the preferred pattern for those hoping to attend law school upon graduation.

The eighteen-hour program stresses the systematic analysis of contemporary legal institutions, coupled with an examination of their historical antecedents, especially those in the Anglo-American common law tradition. All participants in the program are required to develop basic skills of logical analysis, and during their senior year they undertake supervised legal research under the direction of one or more of the participating faculty members.

The program also is designed to expose students to both public and private law, and to courses using the traditional case method as well as those using alternative modes of analysis, e.g., the historical methods.

Required courses (9 credit hours)

Law 11 Introduction to the Law (3)
Phil 13 Practical Logic (3)
Special Topics (3)

This research course of one semester's duration is taken during the student's senior year. The field is designated by the student, e.g., law, philosophy, journalism, history, international relations, government, depending upon the faculty member(s) with whom the student is working.

Elective courses (9 credit hours required with at least one course in both categories)

Category I–Case Method

Law 201	Business Law (3)
Govt 351	Constitutional Law (3)
Govt 352	Civil Rights (3)
Govt 354	Administrative Law (3)
IR 361	International Law (3)
IR 362	International Law (3)
Journ 122	Law of the Press II (3)

Category II–Non-Case Method

Govt 353	Law and Politics (3)
Hist 347	English and Constitutional and Legal History to 1485 (3)
Hist 348	English Constitutional and Legal History Since 1485 (3)
Phil 122	Philosophy of Law (3)

Presidential Prizes

Lehigh University offers each year ten Presidential Prizes valued at $4,000 each, for four years of college. These are reserved for entering freshmen and are awarded on a competitive basis, irrespective of financial need. Each prize provides $500 per semester, credited toward tuition, in any of the three undergraduate colleges of the university.

The prizes, once assigned, continue in force for the full four years of the student's residence at Lehigh University, unless the holder fails to meet the normal scholastic requirement of a 3.00 average or better and the qualifications of a good citizen. In rare instances this requirement may be waived upon unanimous vote of the prize committee and the approval of the president. The prize is based strictly on merit, without regard to financial need.

Fig. 1957. — COMMON OLIVE.
(*Olea Europæa.*)

In order to compete for one of the prizes a freshman candidate must:

1. Be a successful candidate for admission in any of the three undergraduate colleges, Arts and Science, Business and Economics, or Engineering and Physical Sciences, with evidence of promise of high academic achievement.

2. Submit a separate prize application providing more detailed information regarding any important piece of creative work, independent study, evidence of leadership potential, notable accomplishments which do not appear on the regular record submitted for admission, or the promise of making an extraordinary contribution to the life of Lehigh. Thus the applicant may show high achievement in such diverse areas as the arts, the sciences, athletics, original scholarship, literature, or music.

3. Be interviewed by a member of the Lehigh faculty, generally a member of the prize committee. If distance prohibits a campus visit, the interview may be with a selected alumnus or alumna.

All candidates for admission are automatically eligible to compete for one of these prizes and will be so considered. A preliminary selection of finalists is made in January when prize applications are distributed and interviews conducted. Winners are announced in April. It is possible to receive a Presidential Prize and also qualify for other forms of financial aid. The Parents Confidential Statement, however, is not required to be considered for a prize.

Prizes will be made in the order of the contestants' ratings on such weighted factors as secondary school scholastic record, evidence of effective leadership and distinguished group service, character and personality, and performance in the College Entrance Examination Board tests.

The prizes follow the general plan of the prestigious academic scholarships typified by the Rhodes Scholarships. Geographic location will play some part in the final selection. Men and women students are equally eligible.

COLLEGE OF ARTS AND SCIENCE

John W. Hunt, dean; G. Mark Ellis, Saul B. Barber and Joseph A. Maurer, associate deans

The Curricula

The College of Arts and Science offers several curricula options: a. a four-year curricula in the arts and sciences, leading to the degree of bachelor of arts; b. four-year curricula in the fields of biology, geological sciences, geophysics, information and communication science, psychology, and environmental science and resource management, leading to the degree of bachelor of science in the designated field; and c. a five-year curriculum in arts-engineering leading to a baccalaureate degree from the College of Arts and Science and a bachelor of science degree in the student's field of engineering.

Freshman English

Students in all of these curricula must meet a requirement for freshman English. The normal requirement in English 1 and 2, 10, 14, or 16. For exceptions, see Advanced Placement. page 14.

Bachelor of arts degree

The curriculum in arts and science emphasizes a liberal education. It asks the student, in collaboration with his or her adviser, to select courses to fill three general categories, namely, distribution to insure breadth of education, a major field of concentration to provide depth, and free electives to adjust both breadth and depth to the student's individual needs.

Distribution requirements

The objective of the distribution requirements is to give the student an elementary knowledge of the fields of contemporary thought and to orient the student to the world of man and nature.

The requirements also provide opportunities for students to take additional work in fields related to their major field of concentration. In addition, the preliminary requirements give students experience with each of the college's three distribution areas before a major field of concentration must be chosen.

Distribution requirements are administered by the dean of the College of Arts and Science in accordance with the group regulations given below. The student has a wide choice of offerings from which to select courses to fulfill distribution requirements and will have an opportunity to discuss these with his or her faculty adviser prior to preregistration each semester.

There are two types of distribution requirements: preliminary and upperclass.

Preliminary requirements. These should normally be fulfilled by the end of the student's fourth semester of college work. However, when a student's academic program permits it, they should be completed by the end of the third semester. With the exception of courses in mathematics, science, and modern and classical languages, which may be used for either preliminary or upperclass requirements based on the student's progress in the discipline, preliminary courses are indicated by a (P) following the title.

Fig. 1333. — THE IBEX.

At least one course is chosen from each of two subcategories in each of the three distribution areas listed below:

Area I Humanities
a. Classical and Modern Foreign Languages
b. Literature (courses in Egnlish or American literature; Greek, Latin, or modem foreign literature in translation; or foreign literature courses at the third-year level or higher not involving conversation and composition)
c. Philosophy
d. Arts (Music, Drama, Fine Arts)
e. Religion Studies

Area II Social Sciences
a. Government, International Relations
b. Social Relations, Psychology courses designated SS (Social Science)
c. History (including Ancient History) and Archaeology
d. Economics
e. Urban Studies

Area III Mathematics and Science
a. Mathematics, Astronomy and Logic
b. Biology
c. Chemistry
d. Geological Sciences
e. Physics
f. Psychology courses designated NS (Natural Science)

Upperclass requirements. To ensure intellectual breadth in the student's progress towards the bachelor of arts degree, a student fulfills upperclass distribution requirements, normally after the major field has been selected.

These requirements consist of twenty hours elected by the student in courses above the elementary level in the two above-listed distribution areas other than the one which includes the student's major. In the case of mathematics, science and foreign language courses, all course levels may be used to meet the upperclass requirements.

It is expected that each student will fulfill the distribution requirements in a manner that will satisfy the student's intellectual goals and needs as student and adviser perceive them. A student's program, including the choice of distribution requirements, is not official until approved by the student's adviser.

Language opportunities

The study of a foreign language is not required for either the bachelor of arts or bachelor of science degree in the College of Arts and Science. However, students in the college are strongly urged to begin or continue the study of foreign languages and cultures by registering for courses offered by the department of modern foreign languages or classics. Students who are qualified are also encour-

aged to participate in approved study-abroad programs regardless of their major.

The principal purpose of foreign-language study is to develop means of perceiving and understanding a culture other than one's own. The ability to use a foreign language enables the student to communicate with those who are part of a foreign culture. Furthermore, in acquiring such ability, the student sharpens his or her knowledge and use of the English language.

Students who are planning on graduate study toward the doctor of philosophy are reminded that most graduate schools require Ph.D. candidates to demonstrate a reading knowledge of one or two foreign languages. Many careers in commerce, industry, and the Federal Government likewise require ability to use a foreign language.

Major field of concentration

By the end of the sophomore year, each student in the curriculum of arts and science will select some sequence of studies as a major field of concentration.

A major consists of at least twelve hours of advanced work in the field chosen. Including preliminary college work, the minimum number of hours constituting a major is twenty-four.

The major field of concentration is designed to enable a student to master an area of knowledge so far as that is possible during the undergraduate years. In all fields certain courses are prescribed, but the mere passing of courses will not satisfy the major requirements. A student must achieve a minimum 2.0 average in his or her major courses.

Standard major sequences

The student may wish to choose one of the standard major sequences. See the appropriate alphabetical listing under Course Descriptions.

When a student selects one of these standard majors, the chairman of the department offering the major or the official director of a nondepartmental major becomes a student's major adviser and makes out the student's major program. The final responsibility for meeting both major and nonmajor requirements, however, rests with the student.

Special interdisciplinary majors

In addition to the standard major programs, specially structured interdisciplinary major sequences are possible.

For example, a student interested in a professional school or urban or regional planning might be interested in structuring a special major consisting primarily of courses of government and economics, or of economics and social relations.

Any student may, with the aid of members of the faculty chosen from the disciplines involved, work out an interdisciplinary major program to include not less than twenty-four hours of related course work, of which at least twelve hours shall consist of advanced courses. The program must be approved by the major advisers and the dean of the college.

Multiple majors

Some students choose to fulfill the requirements of more than one major sequence. A student initiates this by having separate major programs made out by different major advisers.

Because successful completion of only one major program is required for a baccalaureate degree, a student with more than one program is asked to designate one as the administrative major for preregistration purposes but is expected to maintain normal progress in fulfilling the requirements in both.

Bachelor of Science degree

Students desiring to major in the fields of biology, geological sciences, geophysics, information and communication science, psychology, or environmental science and resource management may elect to work for a bachelor of science degree. This option is also open to arts-engineers desiring to major in one of these fields.

Normally, a student electing to work for the bachelor of science degree will have a strong preprofessional orientation. He or she will take more courses in the major field of concentration than will a student in the bachelor of arts program. In all other respects the student in a bachelor of science curriculum will meet the same requirements as will the student in the bachelor of arts program, except that the bachelor of science candidate is not asked to fulfill the same distribution requirements.

For the specific requirements of the bachelor of science curricula in biology, geological sciences, geophysics, information and communication science, psychology, and environmental science and resource management, please see the Course Descriptions section.

Arts-Engineering option

The curriculum in Arts-Engineering is especially designed for students wishing a regular professional education in a field of engineering and also the opportunity to study broadly or in a second field.

Arts-engineers fulfill all requirements for the professional engineering degree for which they are working. However, the first three years of science and engineering courses are scheduled over four years for the arts-engineer. During this period the arts-engineer is a student in the College of Arts and Science pursuing a bachelor of arts and bachelor of science major program.

In normal circumstances the student will complete work for a degree in the College of Arts and Science at the end of four years. The student transfers for the fifth year to the appropriate department of engineering, where he or she pursues a regular fourth year of science and engineering course work in the chosen field of engineering.

These arrangements make it difficult for an arts-engineer to qualify for the bachelor of science degree in the College of Engineering and Physical Sciences before meeting all requirements for the baccalaureate in the College of Arts and Science. In some instances it may be advisable to take the two degrees at the end of the fifth year. To qualify for both degrees a student must submit for the second degree thirty credit hours in addition to the number required for the bachelor of science in engineering alone.

Arts-engineers working for the baccalaureate of arts automatically fulfill the engineering general studies requirements while filling the distribution requirements of the College of Arts and Science. Arts-engineers working towards the bachelor of science in biology, geological sciences, geophysics, information and communication science, psychology, or environmental science and resource management must pay special attention to the engineering general studies requirements, which must be met in time for the student to qualify for the bachelor of science degree in engineering.

Arts-engineers have the same opportunities for multiple majors and special interdisciplinary majors as are available to students working for the baccalaureate in the college.

Pattern rosters which show the normal combination of courses for the first four years of the arts-engineering curriculum will be found under Arts-Engineering, page 69.

Graduation requirements

The bachelor of arts degree (B.A.)

1. The completion with the required average of a minimum of 120 credit hours of collegiate work, apportioned so as to cover the distribution and concentration requirements.
2. A cumulative average of 2.00 or better in the courses required in the student's major program.
3. Completion of all general requirements applying to all candidates for baccalaureate degrees.

The bachelor of science (B.S.) degree in biology, geological sciences, geophysics, information and communication science, psychology, or environmental science and resource management.

1. The completion with the required average of the minimum number of credit hours of collegiate work indicated for the curriculum.
2. Completion of all general requirements applying to all candidates for baccalaureate degrees.

Note: Basic courses in aerospace studies and military science are carried in addition to required courses for either the B.A. or B.S. degree. No more than six hours in either of these subjects areas may be counted for credit toward graduation.

Requirements

Regular progress. Each student in the college is expected to maintain regular progress towards the baccalaureate degree by carrying a normal course load each semester.

The normal course load may vary between fourteen and seventeen hours depending on the number and difficulty of the courses involved.

Special opportunities

Minor program in the college

Certain departments, divisions and programs in the College of Arts and Science offer an opportunity to minor in an additional field of

concentration other than the discipline which the student chooses for the major field of concentration.

Such a minor consists of at least fifteen hours, the specific content of which is determined by the department, division or program concerned. A minor is optional and if successfully completed, will be shown on the university transcript in the same manner as the major field of concentration. A 2.0 minimum grade-point average is required for courses in the minor.

If a minor program is not listed under the department desired, the student should consult the department head.

Students will declare a minor through their major advisers, who will keep the records concerning it; but it is the student's responsibility to initiate it and seek any necessary advice in the department, division, or program offering it.

The minors from College of Arts and Science departments and programs are available for degrees in other colleges within the university at their option.

Fundamentals of Business minor

In cooperation with the College of Business and Economics, students in the College of Arts and Science may elect a special Fundamentals of Business minor, as follows.

Required background courses

Eco 1	Economics (4 credit hours)
Math 41	BMSS Calculus (3)
Math 44	BMSS Calculus (3) or
Math 21	Analytical Geometry and Calculus I (4)
Math 22	Analytical Geometry and Calculus II (4)
Econ 45	Statistical Method (3) or
Math 231	Probability and Statistics (3)
Acctg 51	Essentials of Accounting
Econ 105	Microeconomic Analysis (3)

Required functional areas

Mgt 269	Management of Operations in Organizations (3)
Mkt 211	Contemporary Marketing (3)
Fin 225	Business Finance (3)

Electives (three courses from among the following):

Acctg 52	Essentials of Accounting (3)
Acctg 111	Computers in Business (3)
Law 201	Business Law (3)
Mgt 270	Conceptual Foundations of Organizational Theory and Behavior (3)
Econ 227	Money and Banking (3)
Econ 119	Macroeconomic Analysis (3)

No student selecting the Fundamentals of Business minor may take more than twenty-five percent of total university course work in business courses (i.e., in finance, accounting, management, and law).

Students who successfully complete this minor and who are admitted to the Graduate School, may expect to complete remaining requirements for the master of business administration degree in one additional year.

Interested students should consult the dean's office in the college.

Technology and Human Values minor

The Humanities Perspectives on Technology program offers a minor in Technology and Human Values involving fifteen hours of work in courses in an interdisciplinary program. Details are listed on page 32.

Law and Legal Institutions minor

An interdisciplinary minor, Law and Legal Institutions, involves eighteen hours of course work in the College of Arts and Science and the College of Business and Economics. The minor is available to students in all three colleges. Details are listed on page 33.

Lehigh-Hahnemann M.D. program

The Hahnemann Medical College and Hospital, in Philadelphia, has established a cooperative program in primary-care medicine with Lehigh University.

The program enables up to ten students to earn the bachelor of arts degree in premedical science or the bachelor of science in chemistry, and the M.D. degree from Hahnemann after six years of study. Preference is given to well-qualified students from the Lehigh Valley and eastern Pennsylvania with a strong inclination towards family-practice medicine. Further details of this program are described on page 29.

Lehigh-Medical College of Pa. M.D. program

Lehigh University and the Medical College of Pennsylvania, in Philadelphia, have a joint educational program which enables selected students, approximately fifteen each year, to earn the B.A. degree in premedical science and M.D. degree after six years of study at the two institutions. Further details of this B.A.-M.D. program appear on page 30.

Honors and the College Scholar program

Qualified students in all curricula of the college may choose to work for either departmental honors or the College Scholar program. Details of departmental honors and the College Scholar program are given under Special Academic Opportunities.

Independent study

Students will find various opportunities for independent study in all curricula and most major sequences. They work out such programs of independent study in collaboration with their major advisers.

On the advice of the chairman of the student's major department, and with the consent of the dean of the college, juniors or seniors of unusual merit who desire to concentrate in their chosen field may be allowed to substitute no more than four or six hours respectively of unscheduled work per semester for an equal number of hours of elective work otherwise required for graduation.

Acceleration

Opportunities for students to accelerate towards graduation include, in addition to advanced placement and work in summer school, rostering course overloads during the regular semester and passing special examinations for credit. Students should see their major adviser or the dean of the college concerning these opportunities.

COLLEGE OF BUSINESS AND ECONOMICS

Brian G. Brockway, dean; Max D. Snider, associate dean

Programs of study

The College of Business and Economics, which is a member of the American Assembly of Collegiate Schools of Business, offers a program of study designed to provide an understanding of the complexities of the managerial process in society, both within and outside the business firm.

Many of the most difficult societal problems today involve decision-making, conflict resolution, and the efficient and effective management of human and physical resources. Studies of business and economics provide fundamental bases for understanding and approaching solutions to many aspects of these problems, particularly as they present themselves to business leaders and administrators in other fields.

Thus the college's undergraduate business program stresses analytical and communication skills for the development and articulation of problem-solving techniques. Educational breadth is provided, equivalent to many liberal arts programs, but with depth of study of business processes such as accounting information systems, financial flows and markets, management processes and the impact of economic variables and forces upon business and social issues.

In essence, the undergraduate education deemed most suitable for young men and women who will be the business leaders of tomorrow is formulated as analytically rigorous but with broad educational foundations combined with an exercise in depth of understanding of business process in the economy in which we live.

This education in fundamentals, principles, and problem-solving mental agility provides the graduates with various options. Some of the young men and women choosing this curriculum have already settled upon business careers. Others will use it as a base for further professional studies, in law, graduate business schools, or specialized graduate training in economics, operations research, or other related fields. Still others go into administrative careers in government or nonprofit institutions such as hospitals and universities. Others apply their talents to professional accounting, financial investment, or management consulting careers. Others go into teaching of economics or administrative science.

Undergraduate education must first of all provide the solid base of analytical skills and acquaintance with a segment of significant and relevant phenomena of our society. Equipped then with learning skills and intellectual facility in problem solving, the student's ultimate career must be of his or her own making.

Business today can no longer be approached with narrow or superficial vocational training. Its problems are strongly conditioned by the state of the economy and even by social issues confronting modern business executives. Thus a strong basis in the social sciences is essential to understanding the nature of business organizations. The student must also touch base with physical sciences and technology. Finally mathematics and computer systems are essential elements of modern decision-making processes. An introduction to all of these is provided in Lehigh's undergraduate program in business and economics.

At the same time the student of today must be provided with options. Initiative and motivation would be stultified in a straightjacketed curriculum. To avoid such rigidity, the necessary exposures to science, language, and other arts are accomplished by optional requirements, within each of which the student has wide choice. Thus the basic curriculum rationale is similar to a distribution requirement in liberal arts, to guarantee breadth of undergraduate educational experience.

Additionally, however, approximately twenty credits required for graduation are completely open for selection on a free elective basis. Thus some students take double majors, since intensive specialization is not required, others carry majors into more advanced levels, while still others choose work across the university ranging from humanities to technical engineering subjects, achieving even greater breadth or more specially tailored combinations than are provided in standard requirements.

Thus the degree of bachelor of science in business and economics represents a liberal educational experience coupled with acquiring an understanding of business and economy. It may lead directly to a fifth-year achievement of the master of business administration degree in the college or at another institution.

Goals of the college

Objectives of the College of Business and Economics are to provide an understanding (at the undergraduate level) and managerial and/or research-teaching expertise (at graduate levels) of the nature of business enterprise decision-making and resource management in the economy. Undergraduate objectives may be summarized as follows:

1. To provide tools of analytical rigor and perspective for continuing learning abilities with respect to the nature of business and its role in the economy.

2. To increase communication skills.

3. To provide breadth of appreciation of the scientific, technological, social science and humanity features of the world in which business is carried on.

4. Through a common body of knowledge to stimulate interest in and acquaint a student with basic business and economic systems of pricing, financial accounting, distribution and management processes.

5. Through a major, to provide each student with a learning exercise in depth in at least one area of business or the economy in which business operates such as accounting systems, finance, economics, economic statistics, foreign careers, management or marketing.

6. To work increasingly with mature students for intermediate and upperclass subject areas of business and economics, as an introduction to professional work or a sound basis for acquiring experience in the field or for graduate education.

Graduate programs leading to the degrees of master of business administration, master of arts and master of science as well as the Ph.D. and doctor of arts degrees are described on following pages.

B.S. in Business curriculum

To obtain the bachelor of science degree in business and economics, 120 credit hours are required.

College core requirements (55 credits)

English and Mathematics (12 credits)

Engl 1	Composition and Literature (3)
Engl 2, 10, 14 or 16	Composition and Literature (3)
Math 41	BMSS Calculus I (3)
Math 44	BMSS Calculus (3)

Business and economics core (43 credits)

Eco 1	Economics (4)
Eco 45	Statistical Method (3)
Eco 229	Money and Banking (3)
Eco 105	Microeconomic Analysis (3)
Eco 119	Macroeconomic Analysis (3)
Acctg 51	Essentials of Accounting (3)
Acctg 52	Essentials of Accounting (3)
Acctg 111	Computers in Business (3)
Law 201	Business Law (3)
Mkt 211	Contemporary Marketing (3)
Fin 225	Business Finance (3)
Mgt 269	Management of Operations in Organizations (3)
Mgt 270	Conceptual Foundations of Organizational Theory and Behavior (3)
Mgt 301	Business Management Policies (3) or
Mgt 306	Entrepreneurship and Business Policy (3) or
Eco 333	Managerial Economics (3)

Note: BMSS stands for biological, management and social science.

Major program (15 credits)

Before the end of the first semester of the junior year, students select a major or field of concentration. A major program consists of sequential or related courses in accordance with one of the designated major programs, as detailed under the heading Course Descriptions. Five majors are offered: accounting, economics, finance, management, and marketing.

Optional courses (30 credits)

The student elects three hours of courses from each of the following four groups:
1. English, speech, journalism or modern foreign language departments.
2. Government, history, international relations, psychology, and social relations departments (including the Division of Urban Studies).
3. Fine arts, classics, mathematics, music, religion studies, and philosophy departments.
4. Biology, chemistry, geological sciences, and physics departments.

The remaining eighteen hours must be taken in any one or more of the departments listed in the four groups above or any one or more departments in the College of Arts and Science, as follows: biology, classics, English, fine arts, geological sciences, government, history, international relations, mathematics, modern foreign languages and literature, music, philosophy, psychology, religion studies, and social relations. One-hour courses are not accepted for the optional courses but may be counted toward electives.

Electives (20 credits)

Normally, any courses in the university for which a student has the prerequisites may be used as electives as long as such courses carry university credits.

Advanced military science and aerospace studies courses may be counted as electives up to six credits, but freshman- and sophomore-level courses in military science and aerospace studies do not carry credit against the 120 hours required for graduation.

Planning courses of study

In addition to freshman English and mathematics requirements, each freshman enrolled in the College of Business and Economics registers for Economics 1.

For the fourth and possibly fifth courses, the student takes courses toward the optional requirement each semester of the freshman year. The normal program for freshmen is fifteen hours each semester.

Accounting 51 is taken in the first semester of the sophomore year. Other business and economics core requirements should be selected with some sampling of introductory courses that may help the student choose the major in the junior year.

The pass-fail option is available for students in the college for elective credits. Courses with passing letter grades must be submitted to meet the core, major program, and optional requirements. Courses taken on a pass-fail basis are classified as elective courses.

The senior year's work must be taken at Lehigh University.

Graduate study in business and economics

The College of Business and Economics offers three degrees at the master's level: the master of business administration, the master of arts, the master of science. On a more advanced level, the college offers the doctor of philosophy and doctor of arts degrees.

Graduate education in the College of Business and Economics distinguishes by emphasis between professional management training through the M.B.A., which generally though not always concludes at the master's level, and graduate pursuit of business and economics subjects in depth for research and/or teaching expertise through the doctoral and related M.A. and M.S. programs.

A candidate for admission to graduate study in the College of Business and Economics offers either the Graduate Management Admission Test (GMAT) for business degrees or the Graduate Record Examination (GRE) Aptitude Tests and the advanced test in economics.

The M.B.A. program

The master of business administration degree is designed to give candidates conceptual, analytical, and operational knowledge of decision-making processes in the management of human and physical resources.

Both internal and external aspects of enterprise and organizations in modern economic systems impinge upon managerial roles. Education in the business professions requires understanding of business functions but also integration of these in the management process. The program requires generalized managerial competence but permits, if the student desires, advanced concentration in such fields as finance, marketing, quantitative or behavioral management, professional accountancy or economics, international trade and finance, labor relations, and so forth.

All candidates for this program are required to take the Graduate Management Admission Test (GMAT) for business degrees. Information about this test may be obtained at many counseling centers or by writing to the Educational Testing Service, Box 966, Princeton, New Jersey 08540.

The courses listed below are available in the evening or on Saturday morning to permit qualified candidates to obtain the degree on a part-time basis. Ordinarily graduates of a four-year program in business and economics complete the M.B.A. in one year on a full-time basis. Normally, two years on a full-time basis is required to complete the M.B.A. degree for those candidates who have not previously completed any of the foundation courses listed below.

Foundation courses (30 hours)

Quantitative Methods and Systems

Acctg 445	Financial Flaws and Accounting Measurements (3)
Acctg 411	Computers and Management (3)
Eco 417	Basic Statistics for Business (3)

Functional and Organization Studies

Fin 401	Managerial Finance (3)
Mktg 407	Marketing Strategy (3)
Mgmt 402	Operations Management (3)
Mgmt 413	Organizational Behavior (3)

Economic and Legal Environment

Eco 409	Money, Banking and Monetary Policy (3)
Eco 405	Microeconomic Theory (3)
Law 403	Commercial Transactions and Business Organizations (3)

Fig. 1436.—A MERCHANT'S FAMILY.

Students are usually given credit without examination for one of the foregoing courses with grades of C or better if taken toward a prior degree earned not more than eight years before first matriculation in the M.B.A. program. Comparable undergraduate courses at Lehigh which will satisfy the foundational course requirements are: Eco 45, 105, 109, 229; Acctg 51, 111; Fin 225; Law 201; Mkt 211; Mgmt 269, and Mgmt 270 or Mgmt 321. In addition, Mgt 302, Quantitative Methods-Conceptual, is strongly recommended.

Required core courses (15 hours)

Acctg 422	*Managerial Accounting (3)
Eco 431	Managerial Economics or
Eco 432	Advanced Microeconomic Analysis (3)
Fin 421	Financial Management (3)
Law 401	Legal Problems in Business (3)
Mgt 451	Managerial Policy and Decision-Making (3)

Note: *Students with more than six credit hours of undergraduate accounting (excluding Acctg 111) must take a 400-level accounting course other than Acctg 422.

Mgt 451 should be taken the last semester before graduation.

Elective courses (15 hours)

Elective credit hours may be selected from desired combinations of 300- and 400-level courses offered in the College of Business and Economics, as described under the various departmental listings. Up to six credits can be taken in other colleges with the consent of M.B.A. advisers.

Of the total of sixty credits, the last thirty credits are taken at Lehigh University and must meet the university graduation requirements for any master's degree. At least one 400-level elective course is required.

Graduate work for research and teaching

The Ph.D. degree

The philosophy of the Ph.D. program is to nurture the individual's intellectual growth so that he or she may independently pursue professional objectives. It is assumed that the individual's level of proficiency, attained at the completion of the degree program, will continue to increase with professional development.

The student is expected to pursue an intellectual and scholarly interest in four areas, including economic theory. The program of study in these four areas is arranged with the chairman of the doctoral committee of the college. This program of study is designed to prepare the student to pass general examinations in the four areas so that he or she may be admitted to candidacy.

Course requirements include competence in quantitative analysis at least through Eco 352, Advanced Statistical Methods (3), and Mgt 302, Quantitative Methods–Conceptual (3), and a course in the history of economic thought. Once the student has satisfactorily completed the general examination, a dissertation committee is organized and its chairman guides the candidate in the preparation of his or her dissertation.

The Doctor of Arts degree

The philosophy of the doctor of arts degree is to provide advanced graduate work with breadth of knowledge, sensitivity and teaching skills in preparation of teaching faculty particularly for two-year and four-year colleges.

A sensitivity core of twelve hours is required. Additional coursework is required in preparation for doctoral examinations in four fields (of which one may be outside the college), including an examination in economic theory. Additional requirements include an internship and dissertation dealing with learning, teaching, or research problems in business or economics.

The Master of Arts and the Master of Science degrees

The master of arts degree is offered to students who qualify in the field of general economic theory and in one other field within the college.

For the master of science degree, the requirements are as specified for the master of arts plus Eco 352, Advanced Statistical Methods (3), and Mgt 302 Quantitative Methods–Conceptual (3).

Eighteen of the minimum of thirty hours required for a master's degree must be taken within the College of Business and Economics. Up to twelve hours of the thirty-hour requirement may be elected from related fields in any department of the university with the consent of the chairman of the doctoral committee.

The Master of Science in Management Science

The management science program is directed toward integrating the scientific method with the functional aspects of organizations by investigating the application of quantitative methodology and systems analysis in the context of such areas as accounting, finance, marketing, production and public service.

This integration provides the student with a broader perspective toward managerial decision-making in private enterprise and/or public administration.

Undergraduate students with prior exposure to engineering, business, economics, mathematics or the physical sciences who desire a professional career as a staff specialist in management science are ideal candidates for the program. In addition, those students who are experienced in, or intend to fill, line manager positions would find the management science background advantageous in dealing with the increasingly complex problems of industrial, commercial, and public service organizations.

For additional information see: Interdisciplinary Graduate Programs, page 50, and Management Science, page 51.

COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES

John J. Karakash, dean; C. W. Clump and Arthur F. Gould, associate deans

The Curricula

The College of Engineering and Physical Sciences includes eight departments. If offers undergraduate and graduate degree programs at the bachelor, master and doctor of philosophy levels. The undergraduate degree programs or curricula each leading to the bachelor of science degree are as follows:

chemical engineering
chemistry or biochemistry
civil engineering
electrical engineering or computer engineering
fundamental science
industrial engineering
mechanical engineering and mechanics
metallurgy and materials science
physics

Information about each of these programs may be found under Course Descriptions, beginning on page 65.

Each of the curricula includes course requirements in the physical sciences, mathematics, engineering sciences, and the advanced engineering or science coursework essential for the particular degree. In addition, each curriculum has General Studies requirements in the humanities and social sciences.

In the past engineering education was identified explicitly and uniquely in terms of the needs of industry. Present-day engineering programs continue to provide and emphasize such preparation. However, the flexibility inherent in the curricula enables students to design personalized programs leading directly into other professional colleges or professions such as medicine, law, government, management or architecture.

The college encourages such mobility. Experience shows that the background provided through the college programs, including "the engineering approach" to identification, articulation and resolution of problems, finds increasingly wider applicability in those areas of activity which call for a combination of practical and conceptual intelligence.

The physical sciences curricula of the college stress fundamentals while providing opportunities for electives in each of the substantive fields within the sciences. Senior-year programs in the sciences can be planned to facilitate transition to either graduate school or industrial laboratories.

Undergraduates with interests in such topical areas as environmental control, biomedical instrumentation, or aerospace can pursue their interests through electives provided in each of the curricula. Effective preparation

for graduate study in such specialties consists of basic programs in engineering and science, along with electives especially chosen for the field of interest. Such electives are chosen from among all the offerings of the university and are usually taken during the senior year.

The early indication of curriculum choice by students in their application to the university is not a commitment on their part. In the second semester of the freshman year, just prior to preregistration for the sophomore year, students do indicate their choice of curriculum. However, since the sophomore-year programs for several curricula are very much alike, it is possible to transfer from one curriculum to another as late as the end of the sophomore year. This is done by means of a petition following consultation with curriculum advisers. There are instances where such a transfer may require one or two courses to be taken during a summer session at Lehigh or elsewhere.

The college recognizes that the four-year programs are not intended to train specialists in a given area but rather to educate students in terms of principles they will apply to problems they encounter in their future professional work. It is for this reason that the degree awarded upon graduation is bachelor of science in a particular division of engineering or science.

Five-year programs combining the liberal arts and engineering, business administration and engineering, or electrical engineering and physics are also provided. In each of these combined curricula one bachelor degree is awarded upon the successful completion of four years of study, and a second bachelor degree is awarded at the end of the fifth year.

The college curricula are designed to provide students with as much latitude as can be made available without compromising the balance and integrity expected of them by accrediting agencies. This is satisfied with the "minimum" program of each curriculum. On the other hand, the college expects each of its students to take full advantage of all opportunities open to them and complete "normal" programs. In each of the college curricula, a few junior- or senior-year electives are indicated as follows: elective (0-3), or electives (3-6), (6-9), etc. Normal programs are those including the higher of the two credit hours shown for each such elective, and minimum programs are those including the lower of the two numbers.

The college, through its advisers, is prepared to help students to use the six to twelve hours of "personal electives" which make the difference between the minimum and normal programs, along with other electives as available in the curricula, toward a personal-interest development program. This may take the form of some concentration in an option or specialty within a student's own degree program, or alternately in a topical area outside a student's own department or outside the college.

Qualified college juniors planning to continue their formal education into graduate school are urged to take advantage of the flexibility in their programs and design their senior-year program in a manner which provides an effective foundation for a master's degree program at Lehigh. Qualified students who plan their programs in this manner can, upon recommendation of the department and with the approval of the dean of the Graduate School, receive credit toward their degree for graduate-level courses they complete over and above their minimum undergraduate program.

Recommended freshman year

The following outline of work for the freshman year is most easily scheduled and satisfies the requirements for all students in the college. For schedules of the work required in the following three years, please refer to the course description of the specific curriculum.

freshman year, first semester (15-16 credits)

Engl 1	Composition and Literature (3)
Chem 21, 22	Introductory Chemistry Principles and Laboratory (5) or
Phys 11, 12	Introductory Physics I and Laboratory (5)
Math 21	Analytic Geometry and Calculus (4)
Engr 1*	Introduction to Engineering Problems (3) or
General Studies	Social Science GS elective (3-5)

freshman year, second semester (15-16 credits)

Engl 2**	Composition and Literature (3)
Phys 11, 12	Introductory Physics I and Laboratory (5) or
Chem 21, 22	Introductory Chemistry Principles and Laboratory (5)
Math 22	Analytical Geometry and Calculus II (4)
Engr 1	Introduction to Engineering Problems (3) or
General Studies	Social Science GS elective (3 or 4)

*Engineering 1, Introduction to Engineering Problems, is a three-hour course offering programming of elementary engineering problems in compiler language through lecture and preparation of problem solution in fields represented by the college curricula. Students elect a three-credit social science course (GS) from the fields of government, history, international relations, or social relations.

**Engl 10, 14 or 16 may replace Engl 2.

General Studies

The General Studies (GS) program is designed to enable students to range widely or to delve deeply into the humanities or the social sciences with the purpose of exploring the value systems, assumptions, and methodologies contained in these areas.

Since all students in the college are expected to complete specified sequences of courses in the physical sciences, and other electives are available for related courses in natural sciences, the general studies program is restricted to the humanities and social sciences.

In addition, students pursuing a bachelor of science degree program in the college can, if they so choose, organize their general studies program to achieve the equivalent of a "minor" in any one of the established areas in the humanities or social sciences. This requires:

1. Identifying the area of interest, i.e., sociology, philosophy, fine arts, literature, etc., and obtaining the approval of the chairman of general studies. A conference with the chairman of general studies is the first step toward this goal.

2. Formulating a course program in the area of concentration jointly with a member of the faculty representing the area of concentration. The names of faculty representatives will be given to students by the chairman of general studies.

In general, the "minor" is earned upon successful completion of a program of not less than fifteen credit hours in the area of concentration. In certain cases a senior paper also may be required. In each and every case the faculty adviser in the area of concentration must recommend the student's work for such recognition. It is essential that students planning to earn a minor in general studies initiate action soon after their freshman year but not later than the beginning of the fifth term.

The general studies sequence of the college starts in the freshman year with six hours of English composition and literature, and a three-hour social science or humanities elective. In the sophomore year four hours of economics are required. By the end of the senior year, a minimum of twelve additional hours (four courses) is completed to satisfy the requirement of a total of twenty-five hours in general studies. Several courses such as Hist 11 and 2, Course of Civilizations, and Phil 100, Philosophy of Contemporary Civilizations, have been developed to meet general studies objectives.

Courses qualifying for credit in general studies are as follows:

required courses (10 credit hours)

Engl 1, and one course from among Engl 2, 10, 14 or 16.
Eco 1

elective courses in humanities and social science (15 credit hours)

Classics: any course

Economics:

Eco 229	Money and Banking (3)
Eco 105	Microeconomic Analysis (3)
Eco 119	Microeconomic Analysis (3)
Eco 303	Economic Development (3)
Eco 305	The Economic Development of Latin America (3)
Eco 309	Comparative Economic Systems
Eco 310	Economic Evolution (3)
Eco 311	Economics of Resource Use (3)
Eco 312	Urban Economics (3)
Eco 313	History of Economic Thought (3)
Eco 335	Labor Economics (3)
Eco 337	Transportation and Spatial Economics (3)
Eco 338	Labor Market Institutions (3)
Eco 343	European Economic Integration (3)

English: any literature course

Fine Arts: any course

Foreign language: any language course on the intermediate or elementary level, classical or modern. If elementary language study is elected, a minimum of five hours must be in one language in order to receive general studies

credit. A student may not elect an elementary course in any language in which he or she has entering credit.

Freshman Seminar

Government and Urban Studies: any course

History: any course

Humanities Perspectives on Technology: upon petition

Information Science:
IS 202 Computers and Society (3)
IS 301 Descriptive Linguistics (3)
IS 302 (Psych 329) Psycholinguistics (3)
IS 320 (Psych 308) Information Processing: Human and Machine (3)
IS 324 Development and Decline of Human Information Processing Abilities (3)

International Relations: any course

Journalism:
Journ 21 Creative Writing (3)
Journ 22 Creative Writing (3)
Journ 111 Problems in Advanced Reportage (3)
Journ 114 Reporting of Public Affairs (3)
Journ 115 Interpretive Writing (3) spring
Journ 118 History of American Journalism (3)
Journ 120 Journalism Proseminar (3) fall
Journ 121 Law of the Press (3)
Journ 122 Law of the Press II (3)
Journ 123 Basic Science Writing (3)
Journ 124 Politics of Science (3)
Journ 125 Environment, the Public and the Mass Media (3)
Journ 311 Science Writing (3)
Journ 312 Advanced Science Writing (3)
Journ 313 Special Topics in Science Writing (3)

Law:
Law 11 Introduction to Law (3)

Music: any course other than 21-78.

Philosophy: any course

Psychology:
Psych 1 Introduction to Psychology (3)
Psych 75 (Phil 75) Behavior Control and Human Values (3)
Psych 107 Child Psychology (3)
Psych 108 Adolescent and Adult Psychology (3)
Psych 131 Psychology of Women (3)
Psych 205 Abnormal Psychology (3)
Psych 211 Insanity: Psychological and Legal Views (3)
Psych 241 Psychological Principles in Systems Design (3)
Psych 308 (IS 329) Information Processing: Human and Machine (3)
Psych 311 History of Modern Psychology (3)
Psych 320 (IS 302) Psycholinguistics (3)
Psych 331 Humanistic Psychology (3)
Psych 353 Personality Theory (3)
Psych 342 Construction of Psychological Reality (3)

Religion Studies: any course

Social Relations: any course

Speech and Drama: any drama course except 11, 12, 13

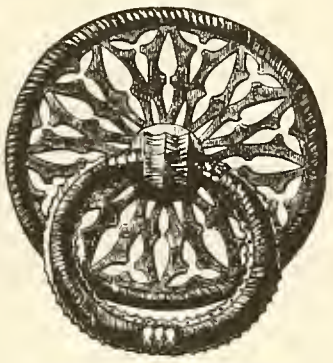

Fig. 1483. — KNOCKER — (15th century.)

Technical minors

Minors are available to students in the college.

First, a student desiring a concentration of courses in an area of the humanities and social sciences may develop a minor in the General Studies program, as described on page 40.

Second, minors are also offered in technical or scientific specialties that are not normally included within the normal curricula. Each program contains at least fifteen credit hours of technical and/or scientific courses. Often some of these courses can be chosen as approved electives in the student's major curriculum; others are chosen as free electives. Presently, technical and scientific minors are available in chemical processing (not open to chemical engineers), computer engineering (not open to electrical engineers), molecular biophysics (not open to engineering physicists or fundamental scientists concentrating in this area), and production management (not open to industrial engineers). Additional minors will be offered as interest warrants.

In some special cases a student in the college, able to incorporate electives within the curriculum which happen to satisfy the requirements of a minor offered by the College of Arts and Science, can, with the permission of the adviser in that college, earn the minor. It must be understood that the courses involved must be completely compatible with the curriculum of the major.

Graduation requirements

Students in good academic standing earn their degree by meeting the requirements of their specific bachelor of science curriculum and university requirements. Waiver of program requirements is approved through petition endorsed by the department and the committee on standing of students.

Students are expected to satisfy the credit-hour requirements of their chosen curriculum. Basic military science or aerospace studies credit hours are in addition to the credit hours specified by the curriculum. Advanced military science or aerospace studies can be included within the normal program of each curriculum, but not within the minimum program.

Students are urged to confer with their curriculum adviser on all matters related to their program.

Honors programs

Each department offers honors work, and adapts this to its curriculum.

Outstanding students may receive permission to do independent study on an unscheduled basis, thereby proceeding more rapidly and more deeply than is possible in regular programs. This enables students who are qualified for and interested in this work to proceed in a direction agreed upon with their honors adviser, leading to the preparation of an undergraduate thesis.

For further information students should see their adviser.

Inspection trips

Inspection trips to industrial plants are a required part of specific courses in various engineering curricula. Written reports may be required. These trips are generally held during the senior year and involve an average expense of $25 to $50. The location of the university in the center of industrial activities of various types furnishes unusual opportunities for visits of inspection to engineering plants.

Arts-Engineering curricula

Under the five-year plan the student is in the College of Arts and Science for four years, earning the bachelor of arts or bachelor of science degree on completion of a program which includes, along with specific bachelor of arts training, the fundamental mathematical, scientific, and engineering subjects of the chosen engineering curriculum.

In the fifth year the student is enrolled in the College of Engineering and Physical Sciences, carrying on a program leading to the bachelor of science degree in the selected curriculum.

Engineering students who decide at any stage of their program to work for both the bachelor of arts and bachelor of science degrees are urged to work with their advisers toward the formulation of an augmented program meeting the requirements of both degrees. If the decision is made prior to the third year, both degree requirements may be satisfied within a total of five years.

Fig. 244. — THE ORNITHORHYNCHUS.

GENERAL COLLEGE DIVISION

The General College Division supplements the work of the established undergraduate curricula by meeting the educational needs of certain special groups of students.

The division aims to provide an opportunity for individuals, not planning a four-year program, to pursue such work, either of a general or a more specialized nature, as their preparation and interests make desirable; a trial period for those who wish to become candidates for baccalaureate degrees but whose preparatory training does not fully satisfy the entrance requirements for the curricula of their choice; and facilities for qualified adults to continue their education without being committed to a restricted or specialized program.

Although all work available through the General College Division will be found at present among the regular offerings of the several departments, the work taken by students in this division is not regarded as primarily preparation for admission to the upper classes of the university; rather, the courses are looked upon as complete in themselves.

Each student in the General College Division has an individual program, one not subject to distribution or curriculum requirements, yet one limited by the student's ability to meet the prerequisites of the courses which he or she desires to take. With but few exceptions, the student enrolled in this division enjoys the same privileges as all other undergraduates in the university, including eligibility to unrestricted prizes, access to student aid, and the right of petition; and is also subject to the same general regulations, those pertaining to scholastic probation not excepted.

The General College Division student will not, however, be a candidate for a degree, save in those instances where transfer to one of the undergraduate programs of study leading to degrees is approved by the committee on standing of students.

THE GRADUATE SCHOOL

Robert D. Stout, dean

Areas of advanced study

Graduate study was a part of the original plan of the university and was announced in its first register in 1866. More definite organization of the work along lines that are now generally accepted dates from 1883. Since that time the degrees of master of arts and master of science have been offered without interruption.

The degree of doctor of philosophy was also announced for a time and twice conferred. In the middle 1890s this degree was withdrawn and doctoral work was not offered until 1936, when it was once more authorized by the trustees. In the same year the Graduate School was organized, with its own faculty. In 1960 a program of studies leading to the degree of doctor of education was offered. A doctor of arts program was begun in 1971.

The Graduate School, in certain areas, offers qualified students opportunity for intensive advanced study and for specialized training in methods of investigation and research, with a view to their development as scholars and independent investigators. The school also aims to serve the needs of teachers and prospective teachers in elementary and secondary schools by providing opportunities for advanced professional training, and by preparing them for administrative positions.

Major work leading to the master's degree may be taken in the following fields: applied mathematics, applied mechanics, biology, business and economics, chemical engineering, chemistry, civil engineering, computer science, economics, education, electrical engineering, English, geology, government, history, industrial engineering, information sciences, management science, mathematics, materials, mechanical engineering, metallurgy and materials science, modern foreign languages and literature, molecular biology, physics, physiological chemistry, political science, psychology, polymer science and engineering, public administration, and social relations. In the fields of the classics, fine arts, and international relations, advanced degrees are not offered; but students majoring in other fields may take collateral work in these fields from the list of courses acceptable for graduate credit.

Work leading to the doctor's degree is offered in the following fields: applied mathematics, applied mechanics, biology, business and industrial economics, chemical engineering, chemistry, civil engineering, economics, education, electrical engineering, English, geology, government, history, industrial engineering, information sciences, mathematics, mechanical engineering, metallurgy and materials science, molecular biology, physics, physiological chemistry, polymer science and engineering, and psychology.

Admission to graduate standing

A graduate of an accredited college, university, or technical institution is eligible for consideration for admission to the Graduate School at Lehigh University. Actual admission is subject to enrollment limitations in each department and is therefore competitive.

An application for admission to the Graduate School may be secured from the office of admission. The candidate should file this application as far in advance as possible of the beginning of the semester when he or she desires to undertake graduate work, but in any event, at least ten days before the start of classes. In addition to the application the candidate should also request that each institution of higher learning which he or she has attended send directly to the office of admission a transcript of the academic record. An application fee of $15 will be charged.

A prospective graduate student is invited to communicate directly with the chairman of the department in which he or she is interested. If it is convenient for the person to visit the university prior to completing admission or prior to registration, a consultation with the department chairman or a representative assists the department in working out a program and aids the student by providing a better understanding of the facilities and opportunities for graduate study at the university.

The submission of Graduate Record Examination scores by a student applying for admission is urged. In the case of foreign students, the GRE scores must be submitted for admission. For information about this examination, write to the Educational Testing Service, 20 Nassau St., Princeton, N.J. 08540. If a student is applying for admission to graduate work in education, scores may be submitted for either the Graduate Record Examination or the Miller Analogies Test. Candidates for graduate work in business administration may submit scores for the Graduate Management Admissions Test. In all three instances, test scores may under certain circumstances be required.

Foreign students are required to submit evidence of competence in use of English. Tests such as those administered by the International Institute of Education or the Educational Testing Service are suitable.

Admission to graduate standing permits the student to take any course for which he or she has the necessary qualifications. It does not imply admission to candidacy for a degree. Admission to candidacy for an advanced degree is granted in accordance with the provisions set forth below under the heading Degree information.

A graduate student who is absent from the university for a semester or more must obtain the written approval of the chairman of the major department in order to be readmitted to graduate standing. If the student has not established a major, he or she must obtain the approval of the dean of the Graduate School.

Students of Lehigh University who are within a few hours of meeting the requirements for the bachelor's degree may, if given permission by the graduate committee, enroll for a limited amount of work for graduate credit.

Resident graduate student

A resident graduate student is one whose primary activity is work toward an advanced degree. The individual must be registered for at least nine semester hours of research and/or coursework toward the degree, and may not receive income from any employment requiring services totaling more than twenty hours per week.

Special student

A student who does not wish or may not qualify for admission to the Graduate School as a graduate student may apply to the office of admission for admission as a special student. The person must hold a baccalaureate degree or have equivalent experience. He or she may register only for courses up to and including the 300 level at the standard tuition rate. Admission depends on approval by both the relevant major department and the Graduate School office. Satisfactory performance as a special student may qualify the student to apply for admission to the Graduate School but no courses taken as a special student may be submitted for credit toward a graduate degree.

Registration

Several days are set aside for graduate registration just prior to the beginning of the semester as indicated in the calendar. However, a student, once admitted, can complete advance registration by obtaining a registration ticket from the department and arranging in advance for an interview with the adviser. Anyone who can register in advance is urged to do so. Normally students are expected to complete their registration before the first day of instruction. Registration after the tenth day of instruction in a regular semester or the fifth day in a summer session is permitted only when the express consent of the dean of the graduate school has been obtained. A $10 late registration fee is charged. Unregistered students are not permitted to attend classes beyond the ten-day grace period.

It should be noted that graduate work itself starts promptly at the beginning of the term, and it is frequently true that graduate courses can be given only if there is a certain minimum demand for them. Delay in enrolling for a given course may therefore cause the course to be withdrawn.

Tuition and fees

The tuition in the Graduate School is $1,775 per semester or $148 per semester hour for 1976-77. For 1977-78, tuition will be $3,825 ($1,912.50 per semester), or $160 per credit hour. An increase is likely for 1978-79. A listener's fee is charged for each course audited, unless the student is already paying the full tuition fee. The maximum full-time roster of graduate courses, including audited courses, is fifteen semester hours. No exception to this rule is made. All students using the resources of the university must be registered, including the semester in which they receive a degree. The minimum registration fee is $150.

In addition to the usual tuition, an intern

student is required to pay a $450 per year intern fee.

Bills are paid at the bursar's office. If desired, payment may be made in installments: sixty percent plus a service charge of three dollars per semester, due prior to registration; twenty percent due one month after registration; twenty percent due two months after registration. The three-dollar service charge is not refundable.

The university will award educational grants to all qualified elementary and secondary school personnel enrolled in the Graduate School. These grants for teachers, either in full-time service or on leave from such appointment, will amount to $75 per semester hour in 1977-78; the student pays the balance of $85.

To qualify for the doctorate, all students must pay tuition fees equivalent to three full years (ninety credit hours) beyond the bachelor's degree or two full years (sixty credit hours) beyond the master's degree. Until these fees are met, resident doctoral candidates must pay a minimum registration fee for nine credit hours each semester and summer period. Similarly, part-time doctoral candidates must register for a minimum of three credit hours of courses or dissertation until the fees are met.

Thereafter doctoral candidacy must be maintained by a registration fee of $150 per semester and summer period until work for the degree is completed. However, resident students who, during their entire doctoral program, have paid continuously full tuition (or ten hours per semester in the case of teaching assistants and research assistants) will be considered as having satisfied the tuition requirements for the doctoral degree if they complete all other degree requirements while so registered.

Doctoral candidates registering for dissertation should indicate credit hours corresponding to the tuition paid (calculated at $160 per credit hour for 1977-78). This procedure will assure that proper credit toward the minimum tuition fees is recorded. When the sum of the program course credits and dissertation credits rostered beyond the master's degree (or its equivalent of thirty semester hours) reaches a total of sixty semester hours, the minimum tuition fees will have been met. The dean of the Graduate School should be consulted in any case where the proper registration is in doubt.

The fee for each language examination required of the student by the department is ten dollars.

The fee for microfilming and binding of the master's thesis is fifteen dollars, the receipt for which is presented with the completed thesis to the Graduate School office.

In the case of the doctorate, the publication fee is forty dollars. If a copyright of the dissertation is desired, an additional fee of fifteen dollars is required.

Identification cards, entitling the holder to attend the various campus events, are issued without charge to graduate students registered for nine credit hours or more.

Transcripts

Each student is entitled to one copy of the record free of charge. This can be an official or unofficial transcript. Unofficial copies are released to the student; official copies are sent directly to the educational institution, company, state board, etc., as the circumstances may require. After the first copy is released, a fee of one dollar is assessed for each subsequent copy.

Refunds

A graduate student who formally withdraws from the university or who, on the advice of the department chairman and with the approval of the dean, finds it necessary to reduce the roster below twelve hours in any regular semester, may qualify for a tuition refund.

The amount of refund is equal to the tuition paid for the course or courses being dropped, less fifteen percent of this tuition for each full or fractional week of the semester computed from the date of the beginning of instruction in courses open to graduate students. There is no refund for semester hours dropped if the remaining roster totals twelve or more hours.

A summer session student who formally withdraws from the university is entitled to receive a refund of the total tuition less five dollars for each credit hour for which the student is registered and less a deduction for each day of regular instruction of four percent of the total tuition paid computed from the first day of instruction in the session.

In the event of the death of a student or involuntary induction into the armed forces, fees will be refunded in proportion to the fraction of the semester remaining at the time of death or induction.

A student who is suspended or expelled from the university is not entitled to any refunds.

Degree information

The maximum roster of a full-time graduate student is fifteen semester hours. Graduate students who are employed elsewhere and can give only part of their time to graduate work must restrict the size of their rosters accordingly.

Graduate students who hold university appointments of any kind are permitted to enroll for only a limited amount of graduate work. Full-time employees of the university may not take more than six semester hours of graduate work in any one semester; half-time employees may not take more than ten semester hours.

With the consent of the chairman of the major department and the chairman of the department concerned, a graduate student may be admitted as a regular listener in one or more courses, which course(s) shall be outside the approved program of studies for the degree, provided that the total number of hours in which he or she is registered and in which the person is a listener shall not exceed the limits set forth above. In no case shall a student who has attended a course as a listener be given an examination for credit in that course. A listener's fee is charged for each course audited.

Students desiring to qualify for graduate degrees in the minimum time should have pursued an undergraduate major in the subject equivalent to that offered at Lehigh. At the discretion of the chairman of the department, a limited number of credits in closely allied subjects may be accepted in lieu of courses in the undergraduate major. Those with undergraduate deficiencies who are admitted because they are otherwise well qualified will be expected to make up such deficiencies in addition to satisfying the minimum requirement for the degree sought.

Filing of application for degree

Candidates for degrees to be conferred on University Day in May or June file with the registrar, on a form provided for the purpose, on or before March 1, a written notice of their candidacy. Candidates for degrees to be conferred at Founder's Day in October file a similar notice on or before September 1. Candidates for degrees conferred in December must file on or before November 15. Failure to file such notice by the dates mentioned may bar the candidate from receiving the degree at the ensuing graduate exercises. If a late application can be accepted, the candidate is assessed a ten-dollar fee to help cover the extra cost of processing.

In addition to the degree requirements set forth below, there may be departmental requirements in the field of the major. These requirements appear in the section on course descriptions.

Master's degrees

The master's degree is granted to properly qualified students who complete satisfactorily at least two full semesters of advanced work. In meeting the requirements for the degree, the student must comply with the following regulations.

Each candidate for the master's degree must submit for the approval of the graduate committee the program of courses he or she proposes to take to satisfy the requirements. This program must have the approval of the chairman of the student's major department, and all courses included which are not offered by the student's major department must also be approved by the chairmen of the departments concerned. The program should be submitted as soon as possible after completion of fifteen credits toward the degree. Approval of the program by the graduate committee signifies that the student has formally been admitted to candidacy for the degree.

The minimum program for the master's degree includes:

Not less than thirty semester hours of graduate work;
Not less than eighteen hours of 400-level course work;
Not less than eighteen hours in the major field;
Not less than fifteen hours of 400 courses in the major field.

The eighteen hours required in the major field are ordinarily taken in one department. Specific exceptions to this rule are mentioned in the departmental statements at the head of course descriptions. The remaining twelve hours of a minimum program, or any part of them, may also be taken in the major department; or they may be taken in any other field

in which courses for graduate credit are offered, as the needs or interests of the student may indicate, subject to the approval of the chairman of the major department. In all cases, the work for the master's degree must be taken under at least two instructors.

Graduate students registered in 200- and 300-series courses may be assigned additional work at the discretion of the instructor.

In order to qualify for the master's degree, candidates are required to submit a thesis or a report based on a research course of at least three credit hours, or to pass a comprehensive examination given by the major department. The department will specify which of these requirements applies, and may specify both. If required, the thesis shall not count for more than six semester hours. The credit to be allowed shall be fixed by the chairman of the major department.

One unbound typewritten copy of the thesis, approved by the faculty members under whom the work was done and by the chairman of the major department, shall be placed in the hands of the dean of the Graduate School with a receipt for fifteen dollars to cover the fee for microfilming at least three weeks before the day on which the degree is to be conferred. Information as to the form in which the thesis must be presented may be obtained from the office of the Graduate School.

The master's degree is not granted unless the candidate has earned the grades A or B in at least eighteen hours of academic work. No course in which the grade earned is less than C is credited toward the degree. A student who receives more than four grades below B in courses numbered 200 or higher becomes ineligible to qualify for the master's degree or to register for any other 400 courses.

All work which is to be credited toward a master's degree must normally be done in attendance at Lehigh University, and must be completed within a six-year period.

When all requirements have been met, the candidate is recommended by the faculty to the trustees for the master's degree appropriate to the work pursued.

Doctor of philosophy

The degree of doctor of philosophy (Ph.D.) is conferred on candidates who have demonstrated general proficiency and high attainment in a special field of knowledge and capacity to carry on independent investigation in that field as evidenced by the presentation of an acceptable dissertation embodying the results of original research. The requirements are more specifically set forth in the following regulations.

Candidacy

Time requirements. A candidate ordinarily is expected to devote three or more academic years to graduate study. In no case is the degree awarded to one who has spent less than two full academic years in graduate work. Study for any specified period of time, however, is not in itself regarded as sufficient ground for awarding of the degree.

Graduate work done in residence at other institutions will be accepted in partial fulfillment of the time requirements, provided such work is approved by the graduate committee and by the departments concerned.

Work of fragmentary character scattered over a long period of years, or work completed many years before the student becomes a candidate for the degree, is subject to special review by the graduate committee. The extent to which such work may be credited towards the fulfillment of the time requirements will be decided by the committee. All postbaccalaureate work submitted in a program for the Ph.D. degree must be completed within a ten-year period. Candidates entering the doctoral program with a master's degree from another institution or after a lapse of several years must complete work within a five-year period.

Residence requirements. A candidate for the degree must complete at least one full academic year of resident graduate study at Lehigh University. The candidate is required to maintain continuous registration until he or she completes all requirements for the degree, including the semester in which the degree is granted.

Approval of the doctoral program. Candidates for the doctorate are accepted in a limited number of departments only, and a department may limit the number of candidates accepted in any year. In passing upon a student's program, the committee takes into consideration the applicant's general education, as well as his or her special qualifications for work in the chosen field. Each applicant is notified by the dean of the Graduate School, in writing, of the action of the committee upon the application.

The student and faculty adviser are expected to initiate steps for approval of the student's program in the first semester following completion of thirty hours of graduate credit. The department determines by examinations or other credentials whether the student is qualified. Application should be submitted to the graduate committee not later than one year after completion of the master's degree or its equivalent. Information on the procedure to be followed can be obtained at the Graduate School office.

The application of a foreign student must be accompanied by a statement from the department in which he or she intends to specialize, certifying that the student has a satisfactory command of English.

A special committee is formed to guide the student in the doctoral program. The student should consult with the adviser on the naming of the committee and the preparation of the application as early as possible after passing qualifying examinations or having been accepted by the department to pursue the degree. The committee is charged with the responsibilities of assisting the student and the adviser in formulating a course of study and preparing a suitable proposal for the dissertation, of overseeing the progress of the student in research, and of assessing the final dissertation. Four members are normally appointed, at least one of them from outside the department. The membership of the committee is approved by the graduate committee.

Plan of work. Preparation for the degree is based on the study of a major subject to which one or two minors may be added.

The program of work, to be formulated by

Fig. 357.— THE YELLOW VULTURE.

Fig. 1554.
ICE-HOUSE AND ELEVATORS AT ROCKLAND LAKE, N. Y.

the candidate, the special committee, and the chairman of the major department, should be planned to lead to a general mastery of the major field and to a significant grasp of any minor that may be added.

While there is no definite requirement as to the number of courses to be taken, two years devoted to formal courses is customary.

Language requirements. Language requirements for the doctor of philosophy degree are the option of, and in the jurisdiction of, the candidate's major department. They are not a university requirement for the degree. Each major department decides which languages, if any, shall form a part of each candidate's doctoral program.

Language examinations are the responsibility of a committee consisting of representatives of the language department concerned and of the candidate's major department. Fee for each examination is ten dollars.

Permission to take the language examination does not imply admission to candidacy for the degree.

Examinations and dissertation

General examinations. The general examinations for the doctorate are designed to test both the student's capacity and proficiency in the field of study. The examinations are not necessarily confined to the content of courses that have been taken at Lehigh University or elsewhere. They are held not later than seven months prior to the time when the candidate plans to receive the degree. The student's special committee is in charge of the examinations, which may be both written and oral.

Should a candidate fail in any part of the general examinations, he or she may be permitted by the graduate committee to undertake a second examination not earlier than five months after the first. If the results of the second trial also are unsatisfactory, no further examination is set.

Dissertation. The candidate is required to present a dissertation prepared under the general direction of a professor at Lehigh University.

The dissertation shall treat a topic related to the candidate's major subject, embody the results of original research, give evidence of high scholarship, and constitute a contribution of knowledge. It must be approved by the professor under whose direction it was written, by the candidate's special committee, and by the graduate committee.

A copy bearing written approval of the professor in charge must be presented to the dean of the Graduate School for transmission to the student's special committee not later than April 15, if the degree is to be conferred in May or June; not later than September 1, if the degree is to be conferred in October, not later than November 9 if the degree is to be conferred in December.

In order that the student receive proper credit for tuition payments toward the minimum required, registration for dissertation should indicate the semester hours covered by the payment.

The candidate shall deposit the following with the dean of the Graduate School, at least two weeks before the degree is to be conferred: the original or perfect black and white typescript of the accepted dissertation, unbound, in standard form, and suitable for microfilming; the first carbon copy of the accepted dissertation; two copies of an abstract of the dissertation, not exceeding six-hundred words, accompanied by a letter from the dissertation supervisor stating that the abstract is acceptable and suitable for publication; a receipt from the bursar for the payment of the publication fee of forty dollars.

The publication fee is used by the university to defray the cost of publishing the dissertation on microfilm (through University Microfilms) and the abstract in *Dissertation Abstracts.* If the candidate wishes to copyright the dissertation, he or she may do so by paying the copyright fee of fifteen dollars to the bursar at the time the publication fee is paid. Arrangements for the copyright in the author's name will then be made by the university through University Microfilms.

Final Examination. After the rough draft of the dissertation has been returned from the Graduate School, the student should distribute copies to the members of the special committee. The student will arrange a suitable date for the defense of his or her dissertation, allowing time for the special committee to examine the draft. The date is sent to the Graduate School office for information.

The examination is open to the public, and the department may enlarge the membership of the official examining committee as it sees fit.

Doctor of arts

The degree of doctor of arts (D.A.) is offered in the fields of business and economics, chemistry, government, and psychology for students who desire to prepare for a career in college teaching in one of those fields.

In every respect, admission standards are equal to those for the doctor of philosophy programs, and the doctor of arts programs have been developed in accordance with guidelines issued by the Council of Graduate Schools.

The requirements for the doctor of arts degree parallel those for the doctor of philosophy with the following exceptions: a broader distribution of graduate courses in the field; a minor area of study for those students wishing bidisciplinary preparation for two-year college teaching; coursework and training in interpersonal awareness; a supervised internship in college teaching, and a project appropriate to college teaching in the field instead of a research dissertation.

Doctor of Education

The degree of doctor of education (Ed.D.) is intended for a limited number of carefully selected students engaged in the fields of administration, counseling, foundations, reading, measurement and research, and teaching. Successful professional experience is required for admission to candidacy for this degree.

In general, requirements for the doctor of education degree parallel those already stated for the doctor of philosophy degree with the exception of the following: language examinations are not required; a statistics competency examination is required; and a residence re-

quirement may be satisfied by an academic year of full-time study or a semester of full-time study preceded or followed by a summer session in which twelve semester hours of credit are earned.

There is enough flexibility in this program to permit certain modifications appropriate to the specific objectives and background of the doctoral student. For more detailed information, consult the dean of the School of Education, and see the pages which follow on the School of Education.

Postdoctoral work

Students who have completed the requirements for the doctorate may enroll for postdoctoral individualized study under the guidance of selected members of the faculty. Such a program of study contemplates a broad educational and research development at advanced and mature levels, and provides opportunities to prepare for specific positions. A formal certification of such work as may be accomplished by the student will be made.

Resources for graduate study

Since the university began in 1961 to encourage the growth of its Graduate School, resources available for graduate study have greatly increased. Considering the graduate program to be composed of formal course instruction and a research experience, the university has developed means to enable students fruitfully to pursue such work.

Research provides a principal method of training and education at an advanced level by concentrated study on a specific problem under close direction of senior faculty members. Such study in theory and experiment assures that classroom teaching is up-to-date; thus research, classroom and laboratory instruction complement each other.

Lehigh has numerous special laboratories to facilitate such research in the sciences and engineering. These laboratories are located in Fritz Engineering Laboratory, which houses the civil engineering department and the world's second-largest universal hydraulic testing machine; Whitaker Laboratory, completed in 1965 for the chemical and metallurgical engineering departments; Sinclair Laboratory, completed in 1970, for surface chemistry and coatings research; Packard Laboratory, for electrical engineering, mechanical engineering, mechanics, and the Computing Center, the most-used laboratory on campus; Williams Hall, for biology, geological sciences, psychology, and the bioelectric research laboratory; the Physics Building; the Chemistry Complex, completed in 1975; Coxe Laboratory, for metallurgy and the electronic microscopy laboratory, and the Sherman Fairchild Laboratory for solid-state physics.

The university's Linderman Library houses more than 500,000 volumes in the humanities and social sciences, including the rare book collection. The Mart Science and Engineering Library houses 100,000 volumes and serves the fields of engineering, mathematics and the natural and physical sciences. Resources of other libraries are available.

Under certain programs, Lehigh graduate students have access to facilities at various industries in the area. Also, some of the major libraries of the country are within an hour's drive.

The university policy is to make its resources available to all faculty and students, including undergraduates, but graduate students dominate student usage of the more sophisticated laboratory facilities and library holdings.

One manifestation of the growth of graduate education at Lehigh has been the organization of interdisciplinary centers and interdepartmental projects and cooperation. Recent success with mission-oriented research using an interdisciplinary approach—that is, scientists and engineers working together on a basic problem—promises an interesting kind of graduate education. Lehigh's interdisciplinary centers offer an opportunity to implement this new approach by directing continuous attention to a given group of problems, stimulating interest in their solution, and, finally, mobilizing the talent across campus required for meaningful research. Besides organizing research, the centers create new courses relative to their research.

Although most graduate students find their interests served by programs available within a single department, some may elect to work in interdisciplinary areas, which reach into two or more departments. Generally, each graduate student's program can be designed to fulfill his or her own particular interests, subject to the requirement that the field thus defined has scope and depth appropriate for an advanced degree regardless of whether its boundaries fall within a single department. Faculty do not regard departmental organization as a limit to the bounds of their scholarly interests.

General information

Campus events. The cultural and athletic events of the university are open to graduate students who request identification cards, and recreational facilities are for the use of all.

Lehigh University provides a wide range of social and athletic activities, concerts and dramatic productions, and art and book exhibits for students and their guests, for faculty, neighbors and alumni.

Housing. Many resident graduate students live in rooms or apartments near the campus, although from time to time a limited number of living accommodations are available in the undergraduate residence halls on the campus. The university owns and operates the Saucon Married and Graduate Students apartment development which opened in 1973. This facility, located in the Saucon Valley, provides efficiency, one-bedroom, two-bedroom, and three-bedroom garden-style apartments in a rural setting.

Inquiries in regard to accommodations for graduate students, either married or single, can be directed to the Residence Operations Office, Rathbone Hall, #63, Lehigh University, Bethlehem, Pa. 18015. The university cannot assume responsibility for locating housing. Since accommodations are scarce, the student is advised to arrange for housing well in advance of beginning residence.

Child care facility. A child care facility is available on a limited basis to Lehigh students, staff and faculty. Children between the ages of six weeks and five years can be enrolled on a first-come, first-serve basis. Fees are charged on a weekly basis, and limited scholarship aid may be available to those in financial need.

The facility, known as the Campus Center, operates five days per week from 7:30 A.M. until 5:30 P.M. It is open year-round. Part-time and full-time care are both available.

The center, which is near the campus, is a joint effort of the Lehigh University Committee on Child Care and Lehigh Valley Child Care, Inc.

Those desiring further information should contact the community relations office, Johnson Hall, #36, Bethlehem, Pennsylvania 18015.

Parking regulations. Graduate students are expected to comply with campus parking regulations. They should register their automobiles at the motor vehicle office, located in Johnson Hall. No fee is charged for this registration.

Accident and sickness reimbursement insurance. The university requires all resident graduate students to carry the accident and sickness insurance coverage which is available at nominal cost at the bursar's office, unless the student can present evidence of approved coverage.

All students are required to carry insurance for both accident and illness either through the university or by other approved policies.

Evening classes. For the benefit of graduate students who by reason of employment in the fields of teaching or industry cannot attend classes during the day, a certain number of courses are generally offered in the late afternoon, evening, and on Saturday morning. It cannot be announced in advance which courses these will be, but a student who is interested may receive the necessary information by communicating, before the beginning of each semester, with the chairman of the department in the field of interest.

In recent years evening and Saturday classes were held in accounting, business law, chemical engineering, civil engineering, economics, English, finance, government, history, industrial engineering, marketing, mathematics, mechanical engineering, metallurgy, and psychology. It is anticipated that in the future courses will be offered as the demand warrants.

Summer session. During the summer, the university offers a comprehensive program for undergraduates and graduate students of two sessions of five weeks each. Many workshops and special programs dealing with pertinent topics such as special engineering courses in surveying, reading and study developmental laboratory programs, overseas programs, and a variety of other special credit and noncredit workshops and conferences are offered. The special-interest programs are designed around the interest of the student population which normally is in attendance at Lehigh.

Financial assistance to graduate students

Scholarships and assistantships

Financial support is available to graduate students from a number of sources and in various forms—scholarships, fellowships, traineeships, teaching and research appointments. The university recognizes the high cost of graduate study, and encourages qualified students to explore all available sources of aid.

Scholarships. A scholarship is a grant which covers or helps to defray tuition. Each is awarded on the basis of academic promise and financial need. No services are expected in return.

Fellowships and traineeships. A fellowship or traineeship is a grant to a graduate student which covers tuition and provides an additional stipend to help meet living expenses.

The university receives funds from individual donors and corporations which provide for the support of several graduate students on scholarships, fellowships and traineeships. In addition, government agencies and foundations offer fellowships and other grants which they award either directly to outstanding students for use at institutions of their choice or to institutions for award by them to the student.

Appointment to these fellowships is for a period of two semesters and may be renewed, provided the work of the holder is of such quality as to justify continuation of financial aid. Usually the research work can be used for thesis or dissertation.

Annual stipends for most fellowships are $2,400 or more, depending upon the qualifications of the applicant. Graduate fellows pay the regular tuition fees. However, the Graduate School, in awarding a fellowship, may award at the same time a graduate tuition grant. This grant provides remission of all tuition fees during the period for which it is awarded.

Teaching and graduate assistantships. Many graduate students hold junior academic staff positions as teaching or graduate assistants. They assist the faculty in grading undergraduate quizzes, instructing in the classroom and laboratory, and conducting recitations.

The departments view seriously the benefits of a teaching or graduate assistantship as a preparation for a career in university teaching.

A number of teaching assistantships are available in applied mechanics, biology, business administration, chemistry, English, education, geology, government, history, international relations, mathematics, physics, psychology, and in chemical, civil, electrical, industrial, mechanical, and metallurgical engineering.

Half-time assistants devote fifteen to twenty hours per week to their duties and receive $3,100 ($3,200 after one year of satisfactory service or to holders of the master's degree) for the 1976-77 academic year plus remission of tuition fees. An increase in these amounts to $3,300 and $3,400 has been approved for 1977-78. Assistants may take up to ten hours of graduate work a semester with remission of tuition.

Appointments to assistantships are made upon recommendation of the department chairman. A student who desires to be considered for such a position should write directly to the department chairman. Forms for admission to the Graduate School should still be filed with the office of admission.

Research assistantships. The university cooperates with industrial concerns, technical associations and government agencies in carrying on basic and applied research. A number of research assistantships are available to qualified graduate students who assist with these research programs.

Many students value the opportunity to participate with senior faculty members in an ongoing project. The experience enlivens their coursework and often determines the thesis topic. Usually, a research assistant's thesis work parallels the contribution to the project.

Applications for research assistantships should be accompanied by evidence of the candidate's qualifications for the appointment sought and sent to the director of the Office of Research or to the chairman of the department concerned.

Research assistants will receive stipends up to $700 per month for 1977-78, depending upon the qualifications and academic programs of the appointee and the time assigned to the project. Appointments are generally for one year and normally are continued upon satisfactory academic progress. Part- or full-time employment on research projects is frequently available during the summer and entering students who hold research appointments usually are encouraged to begin their employment in June or July before the commencement of formal graduate study in the fall.

Research assistants holding appointments for half-time or more will pay a uniform tuition of $1,300 per semester (for 1977-78) until they have met the tuition requirements of the degree for which they are candidates.

Applications. A student may apply for any of the scholarships, fellowships or traineeships awarded or administered by the university, including those granted by national agencies for presentation by the university, by completing the application form available from the office of admission.

Each applicant is automatically considered for all awards for which he or she is eligible. Application must be completed on or before February 1. Each form must be supplemented by an official transcript of the candidate's college work, a statement concerning his or her practical experience, and any other evidence of qualifications which the student may choose to submit.

Scores made by the applicant in the Graduate Record Examination; or, for those in education, the National Teachers Examination; and for master of business administration candidates, the Graduate Management Admission Test are generally required.

Final actions on applications are taken on the recommendations of departments to the Graduate School. Notices of award are mailed in March. In accordance with a resolution of the Council of Graduate Schools in the United States, to which over 180 graduate schools have signified their assent, a student has until April 15 to decline an award.

The holder of a scholarship, fellowship or traineeship may not accept any employment for pay without permission of the dean of the Graduate School.

Student loan funds

The university administers a loan fund program under which financial assistance, long-term and short-term, is available to graduate students.

A student may borrow when there is no other support from the university, or to add to income from a fellowship or assistantship. To be considered, a student must provide complete details of his or her budget.

Information concerning application for a loan may be obtained from the office of financial aid. Available loan funds include:

National Direct Student Loan Program (NDSLP). As federal funds are available to the university, the direct loan program makes it possible to borrow up to $2,500 each year for graduate study to a combined graduate/undergraduate total of $10,000 per person. The office of financial aid determines which students are eligible and the amount of the loan. Repayment begins nine months after the student ceases at least half-time study, and may extend over a ten-year period. Interest charges of three percent also begin at the start of the repayment period.

University Tuition Loan Program (UTLP). Loans are made available on the basis of need to graduate students carrying at least a half-time academic load. Interest charges of four percent annually begin from the date of the note. Repayment begins ninety days after the student ceases at least half-time study, at a minimum rate of $50 monthly.

THE SCHOOL OF EDUCATION

History and purpose

The School of Education was established in 1966, elevating it from its former departmental status under the College of Arts and Science. The School of Education operates in conjunction with the Graduate School in regard to admission, registration, tuition, fees, transcripts, and other related matters.

Degree requirements are also consistent with those established by the Graduate School. The School of Education offers the master of arts in education, the master of education, the master of science in education, and the doctor of education. Details regarding the specific regulations and requirements can be found in the preceding section. Course offerings and other pertinent data may be found in the Course Descriptions section.

The school is interested in the preparation of elementary teachers; secondary teachers; community college teachers; counselors; school psychologists; administrators; reading specialists; curriculum specialists; specialists in the foundations of education; specialists in the education of mentally and emotionally disturbed children; teachers of preschool children, especially those children with handicaps; teachers of nurses; teachers of vocational education; and teachers for social restoration of potential delinquents.

The intern teaching program is specifically designed for qualified persons holding bachelor of arts degrees who desire to enter the field of teaching. The school is particularly interested in established teachers who want to prepare for leadership responsibility in the schools through preparation at the master's and doctorate levels. More than 800 students were involved in advanced study at the master's and doctoral levels in the 1976-77 academic year.

Through its working relationships with other colleges and universities in eastern Pennsylvania, Lehigh has undertaken to complement existing undergraduate preparation programs by emphasizing study at the graduate level. Off-campus coursework and in-service projects are coordinated through the office of consortium activities.

In addition, a fifth-year program is offered to a limited number of qualified holders of B.A. degrees who desire to enter teaching. Those admitted to the program have the opportunity to accomplish their professional training and serve as salaried interns in the public schools. At the completion of two semesters of directed full-time study, students may begin the teaching internship. After the completion of the fifth-year program and the required semesters of intern teaching, such students would ordinarily have completed requirements for the master of arts degree (secondary teachers) or the master of education degree (elementary teachers).

For the benefit of in-service teachers, many courses are offered in the evenings and on Saturday mornings. Teachers in the Lehigh Valley and surrounding regions are encouraged to participate in the life and work of the university.

Fig. 989. — PARRY HALL.

Programs of study

The School of Education offers the master of arts degree, major in education with an academic specialty. Candidates for this degree must include in their program a minimum of twelve hours of graduate work in an academic field. The balance of the program is in the foundations of education and instructional process.

The academic fields which now cooperate with the School of Education in offering this degree include: classical languages, mathematics, English, modern foreign languages, economics, government, social relations, history, international relations, and physical and natural sciences.

Lehigh's program of training for advanced professional responsibility is planned in three stages. The first is represented in the master of education, master of arts or master of science; the second exists in the several specialist programs; and the final stage is the doctor of education.

The master of education (M.Ed.) degree requires, in addition to broad study of the social foundations of education, specialization in a professional field. Special fields include elementary education, elementary administration, secondary administration, general administration, elementary school counseling, secondary school counseling, community counseling, guidance supervisor, school psychology, special education, career education, reading specialist, and reading supervisor. Programs within the secondary division afford opportunity for emphasis in reading instruction, or social restoration.

Although study at the master's level is intense and specialized, the school recognizes that additional training is needed for professional leadership in most areas. Therefore, programs designed for these specialties are extended to the post-master's level.

The master of science (M.S. in Ed.) degree in educational measurements and research, open to both full- and part-time students, is designed to prepare its graduates for an increasing number of challenging positions involving research, testing, and evaluation in school districts, state departments of education, or other educational institutions.

The doctor of education (Ed.D.) program provides for major work in five areas: administration; reading; educational foundations; counseling; and educational measurements and research.

Students are screened for admission in the fall and spring of each year and begin doctoral study the following semester. Formal admission to the doctor of education program usually occurs after the completion of fifteen to thirty hours beyond the master's level. When the student has a proposal accepted by the Graduate School, he or she becomes eligible to take the general examination.

Education divisions

Division of Educational Administration
Charles W. Guditus, director
Elementary school principalship, secondary school principalship, school business management, curriculum administration, school superintendency, community college teachers.

Division of Counselor Education
John A. Mierzwa, director
School psychologist, community counselor, elementary school counselor, secondary school counselor, supervisor of guidance.

Division of Elementary Education
Elvin C. Warfel, director
Elementary teachers (interns), elementary master teachers, reading, special education.

Division of Secondary Education
Robert L. Leight, director
Secondary school teachers (interns), secondary master teachers, educational foundations, career education, social restoration, teaching of nurses.

As of July 1, 1977, the School of Education will be reorganized into three departments instead of the four divisions listed above. The departments are Administration and Supervision, Human Development, and Instruction and Curriculum. Course offerings of the three departments are listed in the Course Descriptions section.

INTER-DISCIPLINARY GRADUATE PROGRAMS

Interdisciplinary graduate programs are offered in the fields of computer science, management science, molecular biology, physiological chemistry, and applied mathematics. These programs are described in this section. Other interdisciplinary programs which do not lead to degrees are described on page 52.

Fig. 381.— BOKHARIAN LADIES TRAVELLING.

Computer Science

An interdisciplinary program is offered in computer science leading to the degree of master of science. It is supported by departments of the university with considerable resources in the field and an extensive list of course offerings. These departments and divisions also are active in research related to computer science, including the following:

1. In electrical engineering, research is under way in equipment organization, software engineering, coding theory, and devices for digital systems.

2. In information sciences, research is conducted in linguistics, information retrieval, and software systems.

3. In industrial engineering, research is concerned with operations research and management systems.

4. In mathematics, research includes automata theory and mechanical theory-proving.

The computer science program is available to students from many undergraduate disciplines. In some cases background courses may be required to provide necessary prerequisites. The student should have the following preparation:

1. Skill in programming in a high-level language, and familiarity with a machine or assembly language.

2. Two years of college-level mathematics.

While the intention is to keep the program as flexible as possible to meet individual interests and needs, the student is normally expected to include in the program the following core subjects: mathematical methods in computer science; non-numerical programming; switching theory, and data structures.

Elective courses may be chosen from one or more of these areas: software and automata theory; hardware and logic design; numerical analysis; linguistics; computability; and applications.

A master's thesis or a research course must be included in the program to qualify for the degree. The student is enrolled for administrative purposes in one of the following departments: electrical engineering, industrial engineering, information sciences, or mathema-

tics. The program, however, is supervised by an interdisciplinary faculty committee headed by the dean of the graduate school.

Management Science

The industrial engineering department in conjunction with the department of management and finance offers an interdisciplinary degree in management science.

The management science program is directed toward integrating the scientific method with the functional aspects of organizations by investigating the application of quantitative methodology and systems analysis in the context of such functional areas as accounting, finance, marketing and production. This integration provides the student with a broader perspective toward managerial decision-making in private enterprise and public administration.

Undergraduate students with a background in engineering, business, economics, mathematics or the physical sciences who desire a professional career as a staff specialist in management science are appropriate candidates for the program. In addition, those candidates who intend to seek line manager positions find the management science background advantageous in dealing with the increasingly complex problems of industrial, commercial, and public service organizations.

The candidate is assumed to have acquired basic competence in the areas of accounting, marketing, corporate finance, production, data processing, microeconomics, linear algebra, calculus, statistics, and introductory operations research.

required courses

simulation IE 418
organizational behavior and structure Mgt 321, IE 334 or Mgt 412
business policy Eco 431
management science project IE (Mgt) 430
nine hours of quantitative methods
six hours selected from a functional area

The minimum program consists of thirty hours of approved coursework.

sample master of science in management science program

IE 418	Simulation
Mgt 321	Organization Behavior
IE (Mgt) 430	Management Science Project
Eco 431	Business Policy
IE 311	Decision Processes
IE 417	Mathematical Programming
Eco 455	Econometric Models
IE 325	Production Control
Fin 421	Financial Management
Fin 431	Advanced Investment Analysis and Portfolio Management

Molecular Biology

The molecular biology program committee, consisting of faculty from the departments of biology, chemistry and physics, administers an interdisciplinary program in molecular biology leading to the master of science and the doctor of philosophy degrees.

The core courses provide a basic background in cellular and molecular biology, biochemistry and biophysics. Present active research areas include studies of molecular analysis of microbial behavior, biomolecular radiation damage, mitochondrial nucleic acids, viral diseases of fish, proteolytic enzymes of marine bacteria, assembly of viruses, cardiac enzymology, mechanisms of phosphate ester hydrolysis, and membrane biophysics.

Students are admitted to the departments of physics, chemistry or biology who have appropriate undergraduate preparation in the respective subject, or have backgrounds in molecular biology, biochemistry, biophysics or microbiology.

Master's degree requirements

The requirements for the master of science degree in molecular biology consist of the following:

Attaining thirty credits of graduate course work, eighteen of which are at the 400 level. Required courses are listed below.

Successful completion of a research project under the supervision of a committee member. A written report of the research must be approved by the research adviser and will be kept on file by the program committee.

required courses for the master of science degree in molecular biology

Chem 371	Elements of Biochemistry I (3)
Chem 372	Elements of Biochemistry II (3)
Phys 367	Introduction to Molecular Biophysics (3)
Phys 368	Molecular Biophysics (3)
Biol 420	Cellular Mechanisms (3)
Biol 447 (Chem 447, Phys 447)	Experimental Molecular Biology (3)
Chem 479	Biochemical Techniques (3)
Phys 491, 492; Biol 407, 408; Chem 474, 475	Research (6)
	approved elective (400 level) (3)

total: thirty credits; eighteen at 400 level

Electives

Students are encouraged to select additional courses from the following list. Other courses may be approved. Note that at least three elective credits at the 400 level are needed to satisfy the master of science requirements.

Biol 325	Advanced Genetics (3)
Biol 353	Virology (3)
Biol 445	Nucleic Acids (3)
Biol 416	Immunology (3)
Biol 425	Biological Electron Microscopy (3)
Chem 358	Advanced Organic Chemistry (3)
Chem 476	Microbial Biochemistry (3)
Chem 477	Topics in Biochemistry (3)
Phys 369	Introduction to Quantum Mechanics (3)
Chem 445	Elements of Physical Chemistry (4)
Chem 423	Bio-organic Chemistry (3)
Phys 451	Topics in Biophysics (1-3)
Chem 480	Advanced Biochemical Preparations (1-3)

doctoral degree requirements

Course requirements for the doctor of philosophy degree are determined on an individual basis by the student and the dissertation committee. This determination is subject to approval by the program committee.

Before completing the requirements for the master of science degree, a student who desires to pursue a doctor of philosophy degree takes a qualifying examination, which may be both oral and written, and is administered by the program committee. Upon successful completion of this examination (which may be taken no more than twice), the student, in consultation with the research adviser, selects a dissertation committee which consists of the research adviser, at least three members of the molecular biology program committee, and at least one faculty member who is not a member of the committee. The dissertation committee must be approved by the program committee and by the graduate committee of the university.

Sometime prior to seven months before finishing the doctor of philosophy dissertation, the student passes a general examination administered by the dissertation committee. The material covered in this examination is not limited to material covered in courses or obtained through laboratory experience. The student may be tested on all and any areas of molecular biology.

Upon completion of a draft of the doctor of philosophy dissertation, the student takes the final exam, which is essentially a defense of the thesis.

Physiological Chemistry

The graduate program in physiological chemistry is an interdisciplinary one leading to the master of science and the doctor of philosophy degrees. The purpose of this curriculum is to prepare individuals who desire to pursue careers in biomedical research, teaching, or administration, or in some aspect of public health.

Individuals enrolled in this program may elect to specialize in one of the following areas: nuclear medicine, medicinal chemistry, chemical and experimental parasitology, invertebrate pathobiology, comparative immunology, and chemical physiology. Their core course distribution and selection of electives may be altered to reflect their area of specialization.

Students participating in this program are enrolled in the department of chemistry and are provided research space in the various laboratories of the university's Center for Health Sciences.

Core Courses

Students select at least six of the following core courses:

Chem 303	Nuclear and Radiochemistry (3)
Chem 336	Clinical Chemistry (3)
Chem 371	Elements of Biochemistry (3)
Chem 423	Bioorganic Chemistry (3)
Chem 424	Medicinal and Pharmaceutical Chemistry (3)
Chem 479	Biochemical Techniques (1-3)
Biol 333	Symbiosis (3)
Biol 416	Immunology (3) or
Biol 432	The Biology of Transplantation (3)

Phys 367 Introduction to Molecular Biophysics (3)
Educ 455 Statistics I (3)*

*A mastery of the application of statistical methods to research can be fulfilled by completing one of several statistics courses available, i.e., Educ 455, IE 410, Psych 421, and Math 231.

Students, with the consent of their graduate committee members, may petition to substitute equivalent courses for some of the required ones. The substitution must be appropriate for the student's area of research concentration. In addition, each student selects, with the guidance of the committee, sufficient courses from the following to satisfy the requirements of the Graduate School.

Chem 310 Instrumentation Principles I (3)
Chem 311 Instrumentation Principles II (3)
Chem 358 Advanced Organic Chemistry (3)
Chem 372 Advanced Biochemistry (3)
Chem 421 Chemistry Research (1-4)
Chem 441 Chemical Kinetics (3)
Chem 445 Elements of Physical Chemistry (4)
Chem 458 Topics in Organic Chemistry (3)
Chem 476 Microbial Biochemistry (3)
Chem 477 Topics in Biochemistry (chemical basis of parasitism immunochemistry) (1-3)
Chem 480 Advanced Biochemical Preparations (1-3)
Chem 481 Chemistry Seminar (1-6)
Biol 303 Invertebrate Zoology (3)
Biol 320 Cell Physiology (3)
Biol 322 Animal Physiology (3)
Biol 353 Virology (3)
Biol 402 Comparative Animal Physiology (3)
Biol 405 Special Topics in Biology (microbiology) (3)
Biol 413 Cytochemistry (3)
Biol 421 Morphogenesis of the Lower Invertebrates (3)
Biol 425 Biological Electron Microscopy (3)
Hist 339 Human Ecology and Public Health in America (3)
Hist 340 History of American Medicine (3)
IR 472 Special Topics (international public health policies) (3)

Students admitted into this program may have majored in biology, chemistry, animal science, entomology, veterinary science, pharmacy, or some other areas of the life sciences.

All students in the doctor of philosophy program are required to satisfy one foreign language requirement and pass a qualifying examination. The completion of a research project is required of master of science students. A dissertation is required of doctor of philosophy students.

Applied Mathematics

The committee on applied mathematics administers programs leading to the degrees of master of science and doctor of philosophy. These programs are interdepartmental and stress the application of mathematics to the physical and social sciences. They provide a broad, rather than a specialized, training in these fields.

The programs also are designed for candidates who have a basic training, either at the bachelor of arts or master of science level, in a field other than applied mathematics. The committee encourages such applicants. The degrees are in applied mathematics with a minor in some specified field of the physical and social sciences.

A candidate for these programs must have a knowledge of basic undergraduate mathematics which includes linear algebra and differential equations (for example, Math 205). If not taken previously, courses in complex variable theory and partial differential equations, although not prerequisites for admission to these programs, must be added to the student's course requirements.

All students in the doctor of philosophy program are required to pass a qualifying examination before the end of their fifth semester (not including summer sessions). For the master of science degree, a thesis is required in addition to the course requirements. Master of science candidates can enter the doctor of philosophy program after completing all course requirements (exclusive of thesis). The date of the qualifying examination for a student entering the program with a master of science degree—not necessarily in applied mathematics—will be determined on admission.

Several types of programs which are available to the student are listed below. These programs are not the only possible ones. Others can be arranged with the consent of the committee.

core courses

Math 320, 322
Chem 464
(Phys 428 and 429 may be substituted for Math 320, 322)

options

1. Engineering Sciences

required
Mech 411, 450

electives
Math 405
Mech 409, 421, 424,
ME 448, 458, 459
CE 459
EE 350, 409
Phys 369, 442
Geol 301
Biol 402

2. Econometrics

required
Eco 206 or 432, 219 or 436, 351

electives
Math 309, 334
Eco 411, 453, 455, 456
IE 416, 418, 425, 426, 427, 429, 311

3. Applied Analysis

required
Math 309, 350
Mech 450, 411

electives
to be chosen from lists under Options 1 and 2.

OTHER INTERDISCIPLINARY ACTIVITIES

The university is engaged in a number of interdisciplinary research activities in which degrees may or may not be available. At Lehigh these encompass polymer science, solid state, energy research, and the Urban Observatory.

Polymer Science and Engineering

Lehigh has a strong and diverse group of faculty with primary interests in polymer science and engineering. In order to provide better opportunities for courses and research in this interdisciplinary field, activities are coordinated through a polymer program committee, with representatives from the departments of chemistry, chemical engineering, and metallurgy and materials science, as well as from the Center for Surface and Coatings Research and the Materials Research Center. For administrative purposes, the committee reports to the chairman of the department of chemical engineering.

Qualified students with degrees in the above or related fields may pursue graduate studies within an appropriate department. The student's adviser may be in that department, in another department, or in a research center. In this case, the student receives a normal departmental degree, but will have emphasized polymer courses and research.

Students also may elect to pursue studies under the auspices of the polymer program committee, towards an interdepartmental degree in polymer science and engineering. The procedures for this case are summarized below.

Master of science degree in polymer science and engineering

For the master of science degree, the student is expected to:

1. Obtain a total of thirty credits of graduate coursework, eighteen at the 400-level and eighteen core credits.

2. Complete a research report to the satisfaction of the faculty adviser, and file with the polymer program committee.

The usual core courses are

Chem (ChE) 390 Synthesis and Characterization Laboratory (3)
ChE (Chem) 393 Physical Polymer Science (3)
Chem (ChE) 394 Organic Polymer Science (3)
ChE (Chem) 400-level polymer course (3)
research (6)

Because polymer science and engineering embrace many variations on the common theme of macromolecules, considerable flexibility in course selection should be main-

tained. If deficiencies exist with respect to other undergraduate courses, additional courses may be required; however, some requirements may be waived for a student who already has a background in polymer science or engineering.

In addition to the required core courses, at least nine elective credits are required at the 400 level. Typical appropriate courses are:

Chem (ChE) 483 Emulsion Polymers (3)
ChE (Chem, Met) 484 Crystalline Polymers (3)
ChE (Chem) 485 Polymer Blends and Composites (3)
Chem (ChE) 492 Selected Topics in Polymer Science (3)
Met 334 Electron Microscopy and Microprobe (3)
Chem 397 Surface Chemistry (3)
ChE 400 Thermodynamics (3)
ChE 413 Catalysis (3)
ChE 428 Rheology (3)
Chem 445 Elements of Physical Chemistry (4)
Chem 497 Topics in Surface Chemistry (3)

Other courses may include departmental courses in topics such as thermodynamics, mathematics, mechanics, statistics, kinetics, solid state, organic or biochemistry, etc.

Doctor of philosophy degree in polymer science and engineering

For the doctor of philosophy degree, the student is expected to:

1. Satisfactorily complete a qualifying examination in a relevant scientific or engineering discipline administered by the appropriate department or, in the case of a student with a background primarily in polymers, by the polymer program committee.
2. Satisfactorily complete graduate coursework determined in consultation with the thesis committee and as approved by the polymer program committee.
3. Satisfactorily complete, prior to completion of the doctor of philosophy dissertation, a general examination (reflecting the polymer field at large) administered by the polymer program committee.
4. Complete and defend to the satisfaction of the thesis committee a doctor of philosophy dissertation and also a general knowledge of the field.

The thesis committee consists of the research adviser, at least two members of the program committee, and at least one faculty member who is not a member of the committee; the committee's composition is subject to approval by the polymer program committee and the graduate committee.

For further information, write to Professor John A. Manson, Coxe Laboratory, #32, Materials Research Center, Lehigh University, Bethlehem, Pennsylvania 18015.

Solid State

Several solid-state research programs leading to the master of science and the doctor of philosophy degrees are available which cut across departmental lines. The departments of chemistry, electrical engineering, metallurgy and materials science, and physics, and two interdisciplinary centers, the Materials Research Center and the Center for Surface and Coatings Research, participate in solid-state activities.

While degrees are granted by academic departments, arrangements may be made for students to carry out their thesis research in either research centers or academic departments, including departments other than their own.

In 1973 Lehigh was awarded a $5.25 million grant by the Sherman Fairchild Foundation for solid-state education and research. This grant provides the following: the Sherman Fairchild Laboratory, completed in 1976, a 16,800-square-foot building which now serves as the focal point of solid-state research activities at Lehigh; an endowed professorship in physics which is now occupied, and one in electrical engineering which is planned to be filled in 1977; eight graduate fellowships; ten undergraduate scholarships; and funds for new scientific equipment. One major facility available in this laboratory is a 3 MeV Van de Graaff accelerator producing both electron and positive ion beams.

For further information, write to Professor W. Beall Fowler, Room 207, Sherman Fairchild Laboratory, #161, Lehigh University, Bethlehem, Pennsylvania 18015.

Energy research

Energy research efforts are coordinated by the university's task force on energy research, which provides internal focus for energy-related activities at Lehigh. Founded in 1972 to help develop faculty awareness of energy problems, it now serves as the major source of information on energy trends and research opportunities.

Most of the departments in the College of Engineering and Physical Sciences, as well as several departments within the College of Arts and Science and the College of Business and Economics, are active in energy research and offer both master of science and doctor of philosophy-level degree programs suitable for energy-related studies. All degrees are granted by academic departments.

Graduate students may find their interests served by programs available within a single department or may elect to carry out their thesis research within two or more departments or within a research center. Each graduate student's program can be designed to fulfill the individual's own particular interests, subject to the requirement that the field thus defined has the scope and depth appropriate for an advanced degree.

For further information write to Professor Edward K. Levy, coordinator, Task Force on Energy Research, Packard Laboratory, #19, Lehigh University, Bethlehem, Pennsylvania 18015.

The Urban Observatory

The Urban Observatory is a unique and innovative effort to assist city officials in resolving the myriad of problems facing them today. It functions as a city center for the administration of research and strives to achieve a pro-

Fig. 141.—PRONG-HORN ANTELOPE, (*A. Americana.*)

gram of urban research which balances public officials' need for specific policy alternatives and academicians' desire to focus on and explain the underlying causes of urban problems.

Accomplishing this goal involves promoting interaction and cooperation between city hall and the academic community. The building of the institutional bridges which results from this city-university interaction is the heart of the Urban Observatory concept.

The Allentown Urban Observatory, located in City Hall in Allentown as a bureau of the department of community development, works through Lehigh University to conduct a wide range of research on urban problems. Each year the Urban Observatory establishes a research agenda, with its policy board making the final decision on which projects will be carried out. This board consists of university officials as well as elected and administrative city officials.

Projects conducted to date have spanned a wide range of academic fields and university departments. Faculty, graduate students, and in some cases, undergraduates have been involved in social science projects such as an input-output model of Allentown's economy, and a citizen participation study; industrial engineering projects such as productivity studies; civil engineering research such as storm water management modeling; and business projects such as creating an accounting and reporting system for Allentown community development funds.

The Allentown Urban Observatory is one of only ten smaller-city observatories scattered around the country. They were established in 1975 through the efforts of the National League of Cities after their initial program of ten large-city urban observatories proved a success. Allentown Urban Observatory research projects have been funded by various federal, state and local sources but a grant from the Department of Housing and Urban Development, administered by the National League of Cities, has been the prime source.

The fact that the university's involvement with the Allentown Urban Observatory is composed of discrete individual research projects means that this is not a degree program or a center for any one type or area of research. It also means that this program offers a unique opportunity to employ faculty and students in using the city as a laboratory for testing technologies to solve urban problems.

For additional information, contact Dr. Joseph F. Libsch, vice president for research; Dr. Roy Herrenkohl, Center for Social Research; or Professor Arthur F. Gould, associate dean, College of Engineering and Physical Sciences.

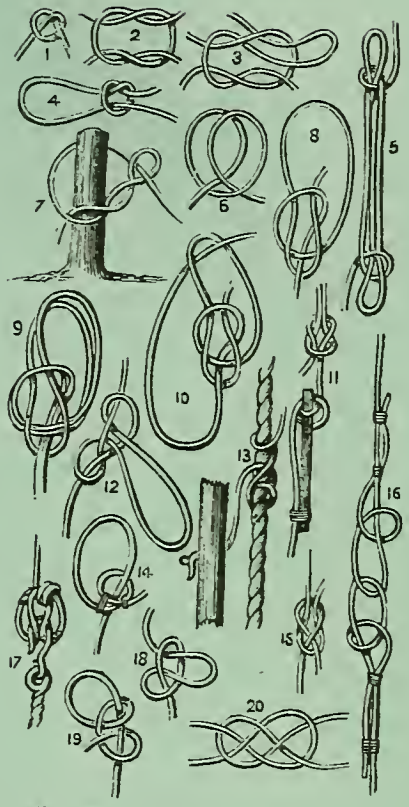

Fig. 1484. — THE TWENTY MOST USEFUL KNOTS.

RESEARCH CENTERS AND ORGANIZATIONS

Ten interdisciplinary research centers and six institutes have been established at Lehigh University to assist the academic departments in developing the full research and advanced education potential of the university in special areas.

The centers and institutes represent research thrusts based on the capabilities and interests of the faculty at Lehigh. Frequently, they relate to the broad-based research needs of government, industry and the social community.

The goal is to provide an effective interdisciplinary framework for programs involving faculty members and graduate students interested in combining traditional course programs with an interdisciplinary research experience.

The research centers, with the exception of the Center for the Application of Mathematics, the institutes and other research-related organizations, are administratively responsible to the office of the vice president-research. The individual who holds this position, Dr. Joseph F. Libsch, has offices in Whitaker Laboratory. The Center for the Application of Mathematics is administratively responsible to the president of the university, Dr. Deming Lewis.

RESEARCH CENTERS

The research centers include the following: Center for the Application of Mathematics; Center for Economic Education, Center for Health Sciences, Center for Information Science, Center for Marine and Environmental Studies, Computing Center, Center for Surface and Coatings Research, Center for Social Research, Fritz Engineering Laboratory, and the Materials Research Center. Personnel associated with these centers are listed on pages 198 to 200.

Center for the Application of Mathematics

The Center for the Application of Mathematics was established in 1965 in order to foster interdisciplinary research related to the application of mathematics, to draw on other disciplines for pertinent mathematical problems, and to encourage the development of advanced courses in the application of mathematics.

The center surveys the need for courses in the application of mathematics and is concerned both with the design of new courses and the reorganization of existing courses so that these needs may be better served.

Research activities

Research programs are currently in the areas of nonlinear continuum mechanics, the propagation of waves in nonlinear media, variational calculus, numerical analysis and biomechanics.

The program on nonlinear continuum mechanics includes fundamental studies in the formulation of continuum theories, the study of anomalous flow phenomena in viscoelastic fluids, the study of finite elastic deformations and stability, and the thermomechanics of materials in which irreversible processes take place and long-range forces may be present.

The program of nonlinear wave propagation includes fundamental mathematical studies of the propagation of both stress and electromagnetic waves in nonlinear media and the application of these studies in a number of areas of physics. Among the areas currently being studied are the propagation of explosive waves in laminated media, the formation of severe storms, the formation of tidal waves and their modification by ocean and shore topography, and the generation of harmonics in high-intensity light beams, such as those produced by lasers.

Both the work on variational calculus and that on numerical analysis are mainly directed to the solution of nonlinear elliptic differential equations. The work on biomechanics is concentrated on the study of transport phenomena in the microcirculation. This includes studies of capillary exchange, interstitial fluid movement and lymph flow, as well as the convection and diffusion of small ions and molecules within the interstitial space. Mathematical studies of the transport and convection of oxygen in the microcirculation also are being conducted.

Educational opportunities

Through the committee on applied mathematics, personnel of the center administer an interdisciplinary program leading to the degrees of master of science and doctor of philosophy. These programs are interdepartmental and stress the application of mathematics to the physical and social sciences.

For further information, write to the center's director, Professor Ronald S. Rivlin, 203 E. Packer Ave., Bethlehem, Pennsylvania 18015.

Center for Economic Education

The Center for Economic Education was established in 1976. It is part of a nationwide network of more than one-hundred-fifty such centers under the guidance of the Joint Council for Economic Education. For over a quarter of a century the joint council has been involved in programs to reduce the level of economic illiteracy in the United States. The purpose of the center is to increase the quantity and improve the quality of economic education.

Located in Drown Hall, the center is part of the College of Business and Economics. Though titled the Center for Economic Education, the center takes on an interdepartmental role as it coordinates programs aimed at heightening understanding of the American business and economic system. The center serves as a clearing house for educational ideas. It also houses an expanding resource library including books, films, filmstrips, curriculum material, testing packets, and simulation games for use by faculty and area educators.

Research activities

The major goal of the center is not primary research. Still the center is undertaking need assessment studies to establish priorities for economic education programs. The center also will be involved in projects to determine effective teaching strategies and testing procedures. In addition to this the center serves to direct programs which involve faculty in projects designed to explore areas of concern such as energy economics, law and economics, capital formation, etc.

The major focus of the center activities revolves around community-oriented programs. These programs are designed to improve economic understanding by giving individuals the tools to deal with economic problems and concepts. Included among these programs are in-service activities for teachers in area schools, assistance for school curriculum development, preparation and distribution of educational materials, an economic education newsletter, and economic workshops for community groups.

Educational opportunities

An integral part of the center's operation is the summer institute for teachers. The institute is designed to give teachers from all levels both the basics of economics as well as assistance in incorporating these concepts into the classroom. The summer institute features courses taught by prominent Lehigh faculty and individualized workshop sessions with education specialists. Participants receive college credit for the institute and may enroll in an ongoing summer program leading to the master of arts in economics degree.

The center also coordinates a teaching assistant training program for graduate students in the College of Business and Economics. As well as improving classroom teaching skills, the project gives students insights into the learning process. Graduate and undergraduate students interested in teaching have the opportunity to work with the center's personnel in individualized study courses geared to explore economic education.

The center also sponsors workshops, seminars and guest lectures designed to meet the educational needs of faculty and students. Sessions such as the American Iron and Steel Industry Economic Seminar allow members of the Lehigh community to meet with academic and business leaders to discuss specific economic issues relating to the industrial process.

For further information, write to the center's director, Professor Bruce R. Dalgaard, Center for Economic Education, Drown Hall, #35, Lehigh University, Bethlehem, Pennsylvania 18015.

Center for Health Sciences

The Center for Health Sciences was organized in 1972. It is concerned with interdisciplinary research and graduate and postdoctoral training in various aspects of the biomedical sciences and bioengineering.

The center is comprised of four divisions: the Institute for Pathobiology, the Division of Biological Chemistry and Biophysics, the Division of Bioengineering, and the Division of Health Policy, History, and Information Services. Facilities are provided by these divisions for its members, postdoctoral fellows, and graduate students actively engaged in research in the respective areas.

A large part of the research conducted at the center is supported by private and public agencies and all are related to either basic or applied aspects of problems pertaining to human and animal health.

Research activities

The research opportunities and programs of each division are described below.

The Institute for Pathobiology. This institute, a branch of the Center for Health Sciences, is an interdisciplinary unit involved with research and graduate and postdoctoral education.

Fields currently represented in ongoing research projects include virology, microbiology, protozoan and metazoan parasitology, invertebrate pathobiology, immunology, biological control, biochemistry, toxicology, epidemiology and epizootiology.

A number of the current research projects are funded by both public and private agencies, including biological control and parasitological studies overseas.

The administrative offices and principal laboratories of the institute are housed in newly renovated quarters in Chandler-Ullmann Hall. These facilities are well equipped for cytological, cytochemical, fine structural, immunological, physiological, biochemical, and tissue culture studies.

The following are some examples of research projects presently being carried out in the institute: possible biological control of invertebrate vectors of human and animal diseases by use of protozoan, bacterial, and viral pathogens; development of efficient molluscicides for the control of vectors of schistosomiasis and fascioliasis; studies on the intermediary metabolism and other phases of the biochemistry of helminth parasites; immunity to bacterial and parasite diseases; diseases and defense mechanisms of marine organisms; chemical changes associated with tumor development.

Division of Biological Chemistry and Biophysics. This research and graduate training unit is a part of the Center for Health Sciences. Fields currently represented in ongoing research include enzyme biochemistry, intermediary metabolism, medicinal chemistry, biosynthesis of organic molecules, the physical basis of surface adhesion in biological systems, clinical chemistry, effects of radiation on nucleic acids, nuclear medicine, radiopharmaceuticals, and biophysics of viruses. Much of the research is being funded from private and federal agencies.

The administrative offices of the division and most of the laboratories are housed in the Seeley G. Mudd Building. The laboratories are well equipped and the major pieces of equipment include infrared, ultraviolet, and visible

spectrophotometers, nuclear magnetic resonance instrumentation, mass spectrometers, fermenters, gas and liquid chromatographic facilities, and other allied bioorganic apparatuses.

This division has an ongoing liaison program with Hahnemann Medical College and Hospital and the clinical aspects of several research projects are being conducted at that institution.

Division of Bioengineering. This research and graduate training unit of the Center for Health Sciences is concerned with a number of health-related problems that are best resolved by individuals with a background in engineering.

Specifically, ongoing projects include measuring the rigidity and tension of healthy and diseased blood cells, the mechanics of flow through the mammalian circulatory system, the fracture mechanics of skeletal units, and the development of prosthetic apparatus and implant materials.

The division's laboratories are housed primarily in Packard Laboratory and the administrative office is in the same building.

Division of Health Policy, History, and Information Services. This research and graduate training unit of the Center for Health Sciences is involved in research and other activities in the health sciences which go beyond conventional laboratory and field research and development.

Specifically, the staff and graduate students affiliated with this division are involved in a variety of studies including the economics of health services, the history of medicine and public health, and the application of the computer in biomedicine.

Some of the ongoing projects within this division include: an analysis of the economic and sociological impact of schistosomiasis, economics of health services, information retrieval of data on the effects of drugs on humans, and the history of yellow fever in the United States.

Educational opportunities

Graduate students working under the direction of members of various components of the center may satisfy their course requirements towards the master of science and the doctor of philosophy degrees by selecting from the offerings of the departments of chemistry, physics, biology, civil engineering, mechanical engineering and mechanics, as well as other departments of the university.

In addition, the interdisciplinary graduate program in physiological chemistry leading to the master of science and the doctor of philosophy degrees (see Interdisciplinary Graduate Programs) is supported by the Center for Health Sciences although all of the students are enrolled in the department of chemistry.

In addition to research, the center sponsors symposia as well as an annual series of seminars on topics pertinent to its objectives.

For further information write to the director, Professor Thomas C. Cheng, Chandler-Ullmann Hall, #17, Lehigh University, Bethlehem, Pennsylvania 18015.

Center for Information Science

The Center for Information Science was established in 1962 as a division of the university libraries. It was reorganized in 1967 as an independent center for research and development with the objective of providing guidance and leadership in transdisciplinary studies of information systems and their operations.

In the last twenty years, the products of science and technology have not only posed unforseen demands on libraries, but also have generated an entirely new complex of ideas concerning the processes of communication. Information science has emerged as a response to these needs and as the result of advances in computer technology.

The field is concerned with the origin, dissemination, collection, organization, storage, retrieval, interpretation, and use of information.

Research activities

The center supports ongoing research projects in the theory, design, development, implementation, management, and operation of computer-based informational systems. Facilities for this research, development, and operation include access to the university's CDC 6400 computer in both time-sharing and batch modes, remote card readers, printers, CRT terminals in the center, and teletypes.

Specific research interests of the center include psycholinguistics, mathematical linguistics, and information retrieval. Research in psycholinguistics involves experimental studies of lexical memory, while activities in mathematical and computational linguistics concern the development of algorithms for the automatic analysis of English sentences. Information retrieval research deals with new techniques of full text searching, interactive question-answering, fact retrieval, data displays, and information regeneration for knowledge transfer networks.

Educational opportunities

The center is closely affiliated with the division of information science within the department of philosophy (see course descriptions). Programs leading to the master of science and the doctor of philosophy degrees are offered by the division. In addition, the division cooperates with the departments of mathematics, electrical engineering, and industrial engineering in supporting the master's degree program in computer science.

In both the master of science and the doctor of philosophy programs in information science, considerable emphasis is placed on mathematics, computer programming, computer languages, statistics, electrical engineering, psychology, sociology, and management science. This widespread involvement of different disciplines is necessitated by the eclectic nature of information science.

For further information write to the director, Professor Donald J. Hillman, Mart Science and Engineering Library, #8, Lehigh University, Bethlehem, Pennsylvania 18015.

Center for Marine and Environmental Studies

Effective utilization of the resources of the oceans requires the cooperation of many scientific and engineering disciplines. Practical solutions for the many critical environmental problems facing the world will most likely be achieved through a combination of engineering and scientific talent.

The Center for Marine and Environmental Studies (CMES) was established in 1962 to foster a multidisciplinary approach to research on these broad problem areas. The staff of the center includes faculty and graduate students from the departments of biology, chemical engineering, chemistry, civil engineering, economics, geological sciences, mechanical engineering and mechanics, and physics.

A good marine scientist is one well-trained in a classical field of science, i.e., biology, chemistry, geology, or physics, who can apply the principles of that discipline to the understanding of complex interacting systems in the oceans. A good ocean engineer is one well-trained in a traditional engineering discipline who can apply engineering principles to problems unique to operations in the ocean. An environmental scientist or engineer needs a broad background in many disciplines, as environmental problems are invariably interdisciplinary in nature.

CMES seeks to provide research opportunities in these fields and to assist faculty and graduate students in applying their academic training and experience to the acquisition of new knowledge and to the solution of real problems.

Research activities

The Center for Marine and Environmental Studies includes a broad spectrum of research activities.

Some of the research in marine science and environmental studies is performed at the off-campus seashore facility of the center, The Wetlands Institute, located near Stone Harbor, N.J. (see listing in this section under institutes).

Through informal cooperation with other institutions having oceanographic facilities and ships, the staff and students affiliated with CMES have a variety of opportunities for experience and work at sea.

Current research activities indicate present interests of CMES staff and include:

Marine science. Coastal salt marsh ecosystems; sublethal effects of pollutants on key marine organisms in the food chain; immunological methods for fish egg identification; biological effects of thermal pollution; biochemistry of proteolytic marine bacteria; fate of fatty acids in mangrove swamps; fine-grained sediment accumulation on a deep-sea fan; deformation of near-surface sediments at a subducting continental margin; shallow water near-shore and estuarine sedimentation; impact of volatile components of oil on marine organisms.

Ocean engineering (Marine Geotechnical Laboratory). Development of geotechnical instrumentation for use at sea; in-place measurement of geotechnical properties of sea-floor soils, both deep-water cohesive soils and con-

tinental shelf sandy soils; slope stability studies; factors affecting development of shear strength in cohesive marine soils.

Environmental studies. Effects of industrial and municipal pollution on streams and rivers; advanced waste water treatment methods; heavy metals in dredge spoils; biological regeneration of activitated carbon; fluidized bed reactors for improved utilization of immobilized enzyme catalysts.

Environmental dynamics. General atmospheric circulation; development of fronts in the atmosphere; dynamics of squall lines, thunderstorms and tornados; tsunamis; earth bow shock structure.

Educational opportunities

Graduate students participating in the center's programs usually receive master of science or doctor of philosophy degrees from traditional academic departments, i.e., biology, chemistry, geological sciences, civil engineering, etc.

Thesis or dissertation research required for the advanced degree may be performed within the framework of the research activities of the center. The program of courses to meet the student's special field of interest and to satisfy departmental and graduate school requirements is arrived at by consultation with the academic department chairman or a special Ph.D. committee.

Courses in marine science, i.e., biological oceanography, marine geology, ocean physics, etc., are offered by the appropriate academic departments. Ocean engineering courses are offered in the civil engineering department. Courses related to environmental studies are offered in the departments of biology, chemistry, chemical engineering, civil engineering, and geological sciences.

Further information concerning educational opportunities may be obtained from the chairman of the prospective major department, or from the director of the center, Professor James M. Parks, Williams Hall, #31, Lehigh University, Bethlehem, Pennsylvania 18015.

Center for Social Research

The Center for Social Research (CSR) is a multidisciplinary organization designed to stimulate, conduct and communicate the results of research involving the social and behavioral sciences, particularly in relation to a technological perspective.

Several disciplines are involved in the activities of CSR: economics, political science, psychology, sociology, and international relations. Through externally funded projects, the center also cooperates with the university's other research centers, such as Fritz Engineering Laboratory, the Computing Center, and the Center for Information Science. Projects are conducted in cooperation with several science and engineering departments.

Founded in 1965 as the Center for Business and Economics, the focus of the center was later broadened and the name changed to the Center for Business, Economics, and Urban Studies. The center's early activities included research on economic and business forecasting and on transportation problems. The change to include Urban Studies broadened the center's scope to encompass the disciplines of political science, sociology and history. In 1972, the center's scope was further broadened to include behavioral science and international affairs, and the center's present name was selected as more accurately reflecting this broadened focus.

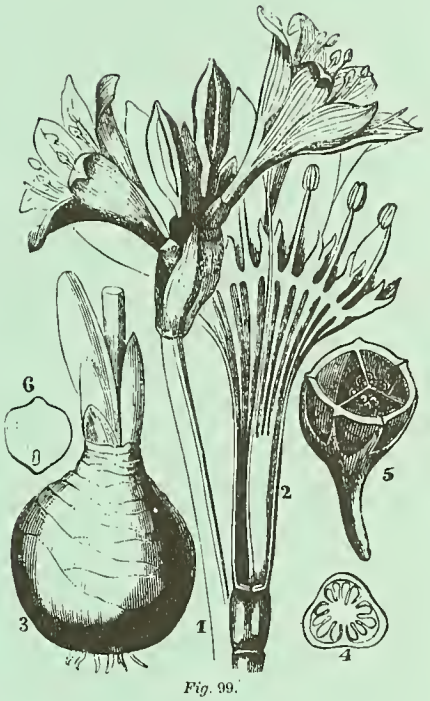

Fig. 99.

Research activities

Current programs of research and development in the Center for Social Research cover the following five broad areas:

Behavioral Research, which includes members of the departments of government, economics, social relations, and psychology.

Business and Economics, which includes members of the departments of economics, accounting, and management and finance.

International Studies, which includes faculty from the departments of international relations, psychology, biology, geology, economics, chemistry, government, the Center for Information Science and the Center for Marine and Environmental Studies, and the Institute for Pathobiology.

Manpower, which includes faculty from the departments of economics, government, psychology, industrial engineering, and social relations and from the School of Education.

Urban Studies, which includes faculty from the departments of government, social relations, economics, and industrial engineering. Much of the research in this latter area is conducted under the Urban Observatory program described on pages 53-54.

Interdisciplinary research

Interdisciplinary research activities are currently in the following areas:

Evaluation research includes the development of computerized systems for maintaining client records in social service agencies, and the conduct of evaluations of social service delivery systems in areas such as mental and physical handicaps, adolescent problems, and child abuse. Work in this area also includes evaluation of educational programs, particularly in the area of science education.

Family dynamics and child development involves study of the family, particularly as a context for child-rearing.

International science and technology affairs focuses on the development of understanding of technology assessment on an international scale. One project in this area is a series of seminars and courses on the international policy-making implications of science and technology.

Social and psychological impacts of built environments focuses on the study of behavioral responses to manmade environments, such as high-rise buildings. Emphasis is on the development of theory and method relevant to this area of study.

Telecommunications policy involves the investigation of policy, and the development of policy alternatives and ways to test their potential impacts on the cable television industry and on society. Particular attention is devoted to establishing a strong capability for research on telecommunications policy.

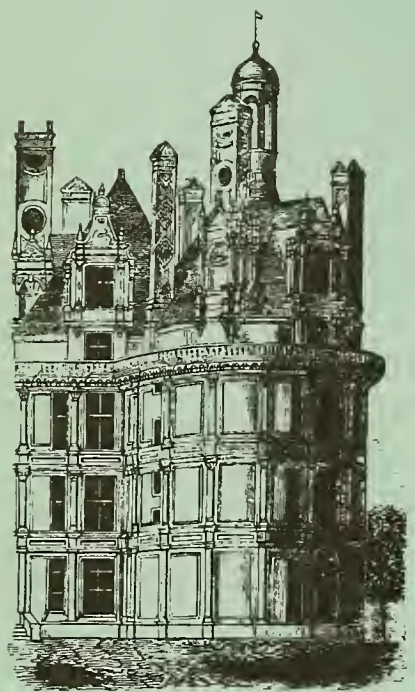

Fig. 2240. — CHÂTEAU DE CHAMBORD, (*Renaissance.*)

The social perspective of CSR's research activities makes them relevant to many facets of activity outside the university in local, regional, national and international affairs. Many research activities are based on a cooperative university-community relationship through which the research goals of CSR are achieved and community needs met.

Educational opportunities

All faculty associates of the Center for Social Research are members of university academic departments and teach in their respective departments. Graduate and undergraduate students from these departments are active in the center's research activities. These departments in most cases offer graduate degrees at the master's level and a few offer the doctorate.

Faculty from the center have participated in the U.S. Department of Health, Education and Welfare-supported two-year project, "International Science and Technology Affairs," which is specifically designed to develop seminars and courses in the area of policy-making related to science and technology.

CSR is associated with the Urban Studies graduate program which provides interdisciplinary training in urban processes. Depending upon interest and choice of courses, students are prepared for careers in city management, urban planning and redevelopment, human relations and social rehabilitation. Master's degree candidates work within the disciplines of economics, government, history or social relations. (See the Urban Studies division course description for recommended combinations of offerings and graduate advisers.)

Financial assistance to graduate students is available through graduate research assistantships provided by research grants and contracts to CSR.

For further information contact the director, Dr. Roy C. Herrenkohl, Center for Social Research, 10 W. Fourth Street, Bethlehem, Pennsylvania 18015.

Center for Surface and Coatings Research

The Center for Surface and Coatings Research, which includes in its structure both the National Printing Ink Research Institute and the Emulsion Polymers Institute, was founded in 1966 in acknowledgment of the fact that surfaces and coatings are of basic scientific interest and technological importance.

Research in surface chemistry was initiated at Lehigh in the early 1940s and was broadened into the field of chemical coatings in 1946 when the National Printing Ink Research Institute began its activities at Lehigh. Interdisciplinary research efforts gained strength in 1966 when a program on stress corrosion cracking was organized under sponsorship of the Advanced Research Projects Agency.

The purpose of the center is to make a coordinated, continuous and competent effort to understand complex surface and coating phenomena. Almost every aspect of life involves a surface; surfaces are rarely bare, but are usually covered with a coating from the atmosphere or from a prior treatment. Even in an ultrahigh vacuum, certain minor elements in a metal have a preference for the surface and diffuse to surface sites. An understanding of the properties of surfaces and the accidentally or purposely applied coating is vital to the electronic, chemical, petroleum, metals, and graphic arts industries.

Twelve faculty from the departments of chemistry, chemical engineering, mechanical engineering and mechanics, and metallurgy and materials science are associated with the center. Ten of these faculty have offices in the 36,000-square-foot Sinclair Laboratory. Three research scientists with backgrounds in chemistry and metallurgy are active in the center's research. CSCR is truly interdisciplinary in outlook and in fact.

Financial support for the center comes largely from research projects contracts with various industries and government agencies. Opportunities for cooperative sponsorship are provided by the center's liaison programs, whereby nonproprietary research is performed in areas of specific interest to the participating sponsors. Current liaison programs are concerned with surface and coatings science and emulsion polymerization. A Laboratory for Color Science is also cooperatively supported.

The center is well equipped with specialty instrumentation needed for advanced research in its field. Sinclair Laboratory houses equipment for experimental studies employing flash desorption, Mossbauer spectroscopy, Auger spectroscopy, X-ray photoelectron spectroscopy, electron spectroscopy for chemical analysis, nanosecond fluorescence spectroscopy, ellipsometry, computerized spectrophotometry, microelectrophoresis, and continuous electrophoresis.

Other specialty equipment includes microbalances, testing machines for studies of environment-affected crack growth, gas adsorption and heat of immersion apparatus, wetting balances, apparatus for determining rheological properties, and apparatus for the preparation of reproducible dispersions and films.

Research activities

The center's research program includes a broad range of topics vital to modern science and technology.

Some of the active topics are: optical and fluorescence studies of surfaces; zeolites; hydrogen-deuterium exchange; solid state chemistry of catalysts; wetting of multiphase systems; monodisperse oxides, characterization of surfaces; microelectrophoresis and continuous electrophoresis; electrophoresis under microgravity conditions; computerized color matching; estimation of color differences; color constancy and metamerism in coatings; light scattering in microvoids; Mossbauer spectroscopy of surfaces; erosion and wear; chemical composition of surfaces; passivity and corrosion inhibition; Auger spectroscopy; chemistry of fracture surfaces, hydrogen embrittlement; environmentally affected crack growth; adhesion of coatings; corrosion under coatings; water-based coatings; polymer surfaces; rate of drying of latex films; preparation of latexes by direct emulsification; particle size determination by hydrodynamic chromatography; rheology in non-Newtonian

fluids; adhesion and flow of fluids in porous substrates; and photovoltaic effects in small particles.

The *Journal of Colloid Sciences* and *Advances in Colloid and Interface Science* are edited by Professor Albert C. Zettlemoyer.

Educational opportunities

CSCR is a facility in which graduate students undertake dissertation research leading to the master of science or doctor of philosophy degree in existing science and engineering curricula. Pertinent courses are offered in the departments of chemistry, chemical engineering, physics, mathematics, biology, metallurgy and materials science, and mechanical engineering and mechanics. A formal program in polymer science is active.

Potential and current graduate students whose interests are consistent with the center's objectives are welcome to associate with the research program and to avail themselves of the experimental facilities. Research assistantships are available. Since research topics are selected by mutual agreement, interested students are encouraged to explore research opportunities with the center's director.

The center's research also forms the basis of continuing educational programs designed primarily for industrial personnel. The conference center in Sinclair Laboratory accommodates the special seminars and short courses which are held periodically. Recent course topics include surface analysis, printing ink technology, emulsion polymerization, computer formulation of colorants, and paint removal.

The center provides opportunities for resident postdoctoral studies and for visiting scientists.

For further information, write to the director, Professor Henry Leidheiser, Sinclair Laboratory, #7, Lehigh University, Bethlehem, Pennsylvania 18015.

Computing Center

With a long heritage of teaching and research in the engineering and science disciplines, Lehigh has made extensive use of computers for more than a decade. In 1966, the need was recognized for an independent organization serving the diverse needs of the academic community and the Computing Center was formed.

Today the center is charged with the responsibility of serving existing requirements while anticipating and preparing for the future requirements of its user community.

With its principal facilities located in Packard Laboratory, the Computing Center serves as a laboratory for departmental courses and research in computer theory and applications, including developmental programs. The center also provides computer services for all departments and centers of the university for solution of instructional, research and administrative problems.

In the summer of 1968, the center installed a Control Data Corporation 6400 computing system. The primary features of this system are great computational speed and accuracy. Peripheral devices include over 700 million characters of on-line disk storage, a communications processor with capacity to support forty-five simultaneous interactive terminals, and two on-line plotters.

The principal programming languages available on the system are FORTRAN, COBOL, PASCAL, BASIC, AND COMPASS (assembler). Major applications packages such as SPSS, the BMDs and the IMSL subroutines included in the program library. Three interactive terminal clusters and two remote batch terminal sites are located around the campus providing public user access in addition to that available in Packard Laboratory.

During 1977, it is expected that an additional computer will be purchased to supplement the CDC 6400. This computer should be operational during the spring semester of 1978.

Research activities

To preserve its role of impartial support for all users, the center does not engage in primary research. It has, from time to time, conducted research-related activities on its own or in cooperation with academic departments or research centers.

Its Computing Associates Program, wherein the center provides the mechanism for industry and government to work with university faculty in the identification and solution of computer-related problems, is an example of such an ongoing cooperative activity.

The center was funded by the National Science Foundation as the lead institution of a regional, educational computing network. Currently, ten educational institutions in the region utilize the Lehigh computer through its telecommunications facilities.

The center's primary role in research is to support the computing activities of the research community. Approximately one-quarter of the computer utilization is devoted to this activity.

Educational opportunities

Seminars on varied topics related to computing are held or sponsored by the center for faculty, staff and graduate students on varied subjects relating to data processing.

The center works closely with the Computer Society to meet the more independent inquiry needs of undergraduates and the society's adviser is a member of the center staff.

Graduate students desiring a more intensive educational experience in an operating environment may apply for one of three teaching assistantships provided by the center.

Along with research, the center's primary method of offering educational opportunities in the use of computers is by providing computing resources for use by the academic community. The majority of jobs processed by the center are submitted by students as a part of their normal academic activities. The growth of interactive processing facilities benefits these users.

See the section on interdisciplinary graduate programs for information on a program leading to the master of science in computer science degree.

For further information, write to the director, Professor John E. Walker, Computing Center, Packard Laboratory, #19, Lehigh University, Bethlehem, Pennsylvania 18015.

Fritz Engineering Laboratory

Founded in 1909, Fritz Engineering Laboratory is involved in the advancement of knowledge and techniques in the fields of structures, structural mechanics, materials, hydraulics and fluid mechanics, geotechnics, and environmental engineering.

Fritz Laboratory is associated primarily with the department of civil engineering. In addition, there are cooperative research efforts with other departments and with other institutes and universities. Research projects are sponsored by national research councils, through the Office of Research, industry and governmental agencies.

Graduate studies combined with research investigations commenced at Fritz Laboratory in 1928. A major expansion of the facilities in 1955 has been followed by addition of the necessary equipment to meet the needs of new research opportunities.

The staff of the laboratory consists of faculty members, research associates, research assistants, and supporting technical personnel. The laboratory awards research assistantships and certain fellowships to competent research personnel who are candidates for advanced degrees. Students from departments and divisions such as civil engineering, metallurgy, mechanics and mechanical engineering and information science are able to take advantage of research opportunities with the laboratory.

Through their work in research programs, individuals are trained for careers in teaching, in research, and in advanced engineering design.

Research activities

The current research divisions indicate present interests and activities of the laboratory staff and include the following:

Fatigue and fracture (brittle failure due to cyclic and impact loading); geotechnical engineering (soil, foundation, rock and pavement mechanics); hydraulics and environmental engineering (stream and channel flow, hydrology, sediment transport in pipes and channels, water quality control, water resources, and waste water treatment); building systems (behavior and strength of building components, frames and over-all systems, problems involved in the design of high-rise buildings, earthquake and wind responses); structural concrete (prestressed and reinforced concrete bridges and buildings); structural connections (welded and bolted joints, composite structures); and structural stability (buckling of plates, beams, columns and frames).

The operations division provides services for laboratory work, and includes an instrumentation group and a computer systems group, the latter maintaining close liaison with the university's CDC 6400 system.

As a result of the research studies conducted by the staff of the laboratory, it has been possible to make basic changes to design procedures and specifications in numerous specialty fields. The laboratory participates in a worldwide exchange of research information, maintains a special library of technical papers appropriate to its fields, and stimulates the publication of papers in technical journals both in this country and abroad.

Educational opportunities

Through the laboratory organization, technical seminars and lectures are presented on current research findings and on new design applications in the various fields of civil engineering and related disciplines.

Courses students select are primarily in the department of civil engineering. However, to gain a broader understanding, many students choose courses from the departments of biology, chemical engineering, chemistry, geological sciences, industrial engineering, mechanical engineering and mechanics, and metallurgy and materials science.

For further information write to the director, Professor Lynn S. Beedle, Fritz Engineering Laboratory, #13, Lehigh University, Bethlehem, Pennsylvania 18015.

Materials Research Center

The Materials Research Center was established in 1962 to fulfill the need for a research and educational facility permitting intellectual stimulation of faculty and students dedicated to research in materials. Currently, approximately 180 persons, including graduate students and faculty members representing science and engineering departments, are engaged in research pertaining to materials science and engineering.

The fundamental objectives of the Materials Research Center are to encourage interaction among the science and engineering disciplines with an interest in materials and to promote interdisciplinary research activity and interdepartmental educational opportunities. To achieve these objectives, the center seeks to establish a climate in which faculty members, research scientists, postdoctoral associates, and graduate assistants develop an awareness of materials; arrange for facilities and space required to conduct interdisciplinary research; guide the search for new materials by encouraging fundamental research and new approaches to materials problems; and assist in developing educational opportunities in materials, in particular, interdisciplinary graduate programs devoted to training for research in materials.

The center also conducts the Materials Liaison Program. Founded in 1963, this program promotes the interchange of knowledge between the materials community at Lehigh and engineers and scientists in industry and government. The program conducts semiannual day seminars on materials research, special lectures, consultation on materials problems and research, distribution of all master of science and doctor of philosophy thesis abstracts on materials research, and seminars with outstanding invited speakers.

The staff consists of members of the departments of chemistry, chemical engineering, electrical engineering, mechanical engineering and mechanics, metallurgy and materials science, and physics. Members of other departments and centers frequently are involved in cooperative programs. Communication with these associated units is achieved through the Materials Research Council, which is composed of senior faculty members from all of the engineering departments as well as from the department of geological sciences and appropriate centers. The council serves in an advisory capacity as well as a channel for information.

Research activities

The present organization of the Materials Research Center includes four laboratories: the advanced materials laboratory, located in the Sherman Fairchild Laboratory, and the ceramics research, mechanical behavior, and polymer laboratories, all located in Coxe Laboratory. Current interdisciplinary research activities include:

Advanced materials. Characterization of metal oxide films; defect structure of amorphous and crystalline materials on both bulk and thin film form; preparation and properties of materials for solid-state devices; processing of metal-insulator-semiconductor structures and their evaluation and application to integrated circuits; structure and properties of sputtered and evaporated thin films.

Ceramics. Deformation mechanisms, including creep and hot-pressing, and deformation mapping for ceramic materials; thermal diffusivity and conductivity of refractory materials; defect chemistry and electrical properties of ceramic oxides.

Mechanical behavior. Effect of complex load interactions on fatigue crack propagation (FCP); deformation, fatigue and creep rupture response of eutectic composites; fatigue crack propagation of polymeric materials; fracture characteristics of bridge steels; fatigue of weldments; metallurgical aspects of fatigue behavior in engineering alloy systems; fracture mechanism studies by transmisssion and scanning electron microscopy.

Polymers. Fatigue crack growth and relaxation processes in engineering plastics and composites; structure, morphology and mechanical behavior of interpenetrating polymer networks; thermosetting resins and vinyl polymers; permeability and behavior of membranes, coatings, and filled polymers; novel polymer concrete systems.

Educational opportunities

This center facilitates interdisciplinary programs of study and research that cross the traditional boundaries of science and engineering curricula, providing a fundamental, broad approach to the field of materials science and technology.

Graduate students participating in the center's program usually receive master of science or doctor of philosophy degrees in the traditional discipline of their choice, i.e., chemistry, physics, metallurgy and materials science, electrical engineering, etc.; however, they are expected to pursue coursework related to a broader understanding of materials and conduct research on an interdisciplinary materials problem in one of the center's four laboratories. A special program leading to a master of science in materials is described in the section on Five-Year Programs.

Financial support for graduate students is available through the Materials Research Center by means of research assistantships related to sponsored research programs, and from the operating funds of the center.

For further information write to the director, Professor Donald M. Smyth, Coxe Laboratory, #32, Lehigh University, Bethlehem, Pennsylvania 18015.

INSTITUTES

Lehigh University has six institutes. They include the Emulsion Polymers Institute, the Lawrence Henry Gipson Institute for Eighteenth-Century Studies, the Institute for Metal Forming, the Institute for Pathobiology, the National Printing Ink Research Institute, and The Wetlands Institute. Staff members of these institutes are listed on page 200.

Emulsion Polymers Institute

The Emulsion Polymers Institute was established in 1975 to provide a focus for graduate education and research in the area of polymer colloids. Formation of the institute constituted formal recognition of an activity that has grown steadily since the late 1960s.

The institute is located organizationally within the Center for Surface and Coatings Research and has close ties with polymer and surface scientists in the Materials Research Center and the departments of chemical engineering and chemistry.

Polymer colloids or polymer latexes, as they are more commonly called, are finely divided polymer particles which are usually dispersed in an aqueous media. Important products produced and utilized in latex form include synthetic rubber, latex paint, adhesives, paper coatings, and many others. The small particle size of typical latexes makes their colloid properties as important as the polymer properties for a number of applications. Hence the study of emulsion polymers is of necessity an interdisciplinary activity.

Research activities

The emulsion polymers research program includes a broad range of problems in the areas of preparation, modification, characterization, and application of polymer latexes. Most commercial polymer latexes contain a number of important ingredients; some in only small quantities.

Research programs at Lehigh are aimed at understanding the function of recipe components during preparation and application of the latexes. The research projects are a blend of fundamental and applied efforts as well as a mixture of theoretical and experimental problems.

Significant research support for institute activities is obtained from industrial organizations via their membership in the Emulsion Polymers Liaison Program. Hence some considerable effort is made to relate the research results to industrial needs. Consequently, graduates find numerous opportunities for employment.

Educational opportunities

Graduate students in the institute undertake dissertation research leading to the master of science or doctor of philosophy degrees in existing science and engineering curricula or in the polymer science and engineering program.

Programs of study for individual students are designed to meet the student's interests, the requirements of the appropriate academic

Fig. 2239. — WHITE-TAILED REMORA.

department, and the student's dissertation committee. Considerable flexibility is permitted in the selection of courses and a research topic.

Faculty members of the institute are involved in teaching normal university courses and continuing education courses for industrial personnel. The annual one-week short course, Advances in Emulsion Polymerization and Latex Technology, typically attracts about one-hundred industrial participants and twenty Lehigh students. This course is an important mechanism for developing meaningful interactions between institute staff and students and industrial scientists and engineers. Educational and research opportunities exist for postdoctoral students and visiting scientists as well as resident graduate students.

For further information write to Professor Gary W. Poehlein, Whitaker Laboratory, #5, or Dr. John W. Vanderhoff, Sinclair Laboratory, #7, Lehigh University, Bethlehem, Pennsylvania 18015.

Lawrence Henry Gipson Institute for Eighteenth-Century Studies

The Lawrence Henry Gipson Institute for Eighteenth-Century Studies, established in 1971, serves as a memorial to one of America's most distinguished scholars.

It helps to support the research activities of the Lehigh community of humanists and social scientists interested in developing a further understanding of the period of history epitomized in Professor Gipson's monumental life work, *The British Empire Before the American Revolution* (15 volumes, written from 1936-1970).

Through its council, the Gipson Institute awards research grants and fellowships from the income of its endowment, a fund made possible by Professor Gipson's bequest of his entire estate to Lehigh. To further the scope of the original endowment, the council of the institute seeks additional support by promoting research and other programs related to the eighteenth century.

Research activities

The income from the endowment of the Gipson Institute, and other funds, provide for the following:

Faculty research grants to defray travel cost, microfilming, and other such expenses.

Graduate student grants to help support deserving students during their dissertation year.

Internal seminars to bring together the eighteenth-century interests of faculty and graduate students and to stimulate interdisciplinary research activities. These seminars are broad in scope and include faculty from neighboring institutions.

Interdisciplinary graduate courses in eighteenth-century studies to provide students, who normally concentrate on one discipline, with a grasp of other significant developments and an understanding of the rich cultural and intellectual milieu of the eighteenth century. Such courses stress the interrelationship of history, politics, literature, fine arts, philosophy, psychology, and the sciences.

Annual symposia to honor the late Professor Gipson, involving distinguished scholars in eighteenth-century studies to lecture and also to discuss opportunities for further scholarly exploration.

Additional research resources for the library.

Faculty fellowships for the pursuit of research in an eighteenth-century topic.

A national Lawrence Henry Gipson fellowship awarded on a competitive basis to a promising graduate student in eighteenth-century studies.

Educational opportunities

Among the academic departments involved in eighteenth-century studies are English, government, history, modern foreign languages and literature, fine arts, music, philosophy, psychology, and social relations.

For further information write to the coordinator, Professor Lawrence H. Leder, Maginnes Hall, #9, Lehigh University, Bethlehem, Pennsylvania 18015.

Institute for Metal Forming

The Institute for Metal Forming, sponsored by the department of metallurgy and materials science, was established in 1970 with the following objectives: to teach the principles and applications of metal-forming technology to graduate and undergraduate students; to provide instruction and equipment for graduate research in metal-forming processes; and to assist industry with solutions to problems in metal forming.

Metal-working processes are analyzed mathematically (usually involving the computer). The results of the analyses are checked and refined by comparison with experimental data obtained in the fully instrumented metal-forming laboratories which are part of the facilities of the institute.

In addition, an important part of the effort of the institute is the preparation of educational programs using the latest audiovisual techniques. These programs are used in the classroom and in institute-sponsored seminars on campus and at industrial facilities.

Long-range planning, together with major equipment acquisitions and construction, is supported by university funds, federal funds, and an industrial consortium.

Research activities

Several of the current research areas are the following: hydrostatic extrusion; pressure-induced ductility; flow through converging conical dies; effect of holes, inclusions and pressure on the tensile properties; friction measurement; cladding and forming of composite materials; forming of polymers; deep drawing, impact extrusion and ironing; powder consolidation.

Educational opportunities

Students interested in metal forming should refer to course descriptions for the departments of metallurgy and materials science and mechanical engineering and mechanics. In addition, the institute offers special informal seminars and lectures for graduate students.

For further information write to the director, Professor Betzalel Avitzur, Whitaker Laboratory, #5, Lehigh University, Bethlehem, Pennsylvania 18015.

Institute for Pathobiology

The Institute for Pathobiology was established in 1971 an an independent research unit. However, it became a division of the Center for Health Sciences when the latter was recognized in 1973.

The personnel affiliated with the institute are involved in research and graduate training in several aspects of the biomedical sciences. Specifically, the staff is concerned with research in the areas of microbiology, protozoan and metazoan parasitology, immunology, biological and chemical control of vectors of disease-causing organisms, toxicology, medical and public health ecology, and selected areas of developmental biology.

Research activities

Research currently being conducted at the institute includes the isolation and characterization of microorganisms potentially useful in the control of the snail transmitters of schistosomiasis, fascioliasis, and other helminthic diseases; the development of new specific molluscicides and insecticides; studies on the biochemistry and physiology of parasitic nematodes and trematodes with the objective of developing new chemotherapeutic compounds; examination of immune mechanisms in invertebrates; cell and tissue culture; isolation and characterization of toxins in edible marine animals; studies on the chemical basis of development of model organisms; and chemical changes in tumor cells.

Educational opportunities

Although graduate students participating in the interdisciplinary master of science and doctor of philosophy program in physiological chemistry are enrolled in the department of chemistry, they are provided with research facilities and support by the Institute for Pathobiology as well as other divisions of the Center for Health Sciences.

For further information concerning graduate postdoctoral research opportunities at this institute, contact Dr. Thomas C. Cheng, director, at Chandler-Ullmann Hall, #17, Lehigh University, Bethlehem, Pennsylvania 18015.

National Printing Ink Research Institute

The National Printing Ink Research Institute (NPIRI) was established at Lehigh in 1946 to carry out fundamental research for the printing ink industry. It is Lehigh's oldest research institute.

In 1966, NPIRI was incorporated into the newly formed Center for Surface and Coatings Research because its activities formed an integral part of the center's area of interest. Until 1970, NPIRI was housed in Chandler-Ullmann Hall, along with the department of chemistry, but then moved with the center into Sinclair Laboratory, which was built in large part with contributions form the printing ink industry.

The purpose of NPIRI is to carry out fundamental research in its areas of specialization, i.e., to apply the principles of colloid, surface and polymer chemistry to the broadest aspects of printing ink and paper, as well as to the printing process itself.

The institute's financial support comes principally from research contracts and grants. Current sponsors include the National Association of Printing Ink Manufacturers, U.S. Postal Service and National Science Foundation, as well as various companies.

Research activities

NPIRI's traditional areas of research are dispersion of pigments, rheology of printing inks, surface chemistry of lithography, printability, test methods, and instrumentation.

More recently, its research interests have expanded to include computer color-matching, safety and health aspects of printing inks, optical properties of ink films, recycling of wastepaper, and ultraviolet light-cured inks.

Its laboratories are completely equipped with proof presses and various test instruments to carry out work in these areas. Of particular interest is the Color Science Laboratory, which is equipped for all types of color measurement, and the Printability Laboratory, which is equipped to handle most printing problems.

Educational opportunities

The institute offers opportunities for graduate study leading to the master of science and the doctor of philosophy degrees. Its graduate students are drawn from the various academic departments, e.g., the departments of chemistry, chemical engineering, and psychology.

NPIRI also offers undergraduate research opportunities, such as theses subjects tailored to the individual student or larger programs involving several students. The 1974 National Science Foundation summer project on recycling of wastepaper, which involved six undergraduates, is an example of the latter.

Students who are interested in the institute's areas of specialization are welcome to associate with its program and to use its experimental facilities. Research topics are selected by mutual agreement between the student and the faculty adviser. Prospective students are encouraged to explore these opportunities with the institute's director.

NPIRI's other educational activities include a biennial Summer Course in Printing Ink Technology as well as meetings on special topics, e.g., Rheology of Printing Inks in 1972, Ecology in the Graphic Arts Industry in 1972 and 1973, and Raw Materials Supply in the Printing Ink Industry in 1974. Other activities include the Test Methods Index, a compilation of test data applied to inks and coatings, and the Raw Materials Data Handbook, a compilation of the physical, chemical, fire hazard and safety hazard properties of the ingredients used in printing inks.

For further information, contact the director, Professor John W. Vanderhoff, Sinclair Laboratory, #7, Lehigh University, Bethlehem, Pennsylvania 18015.

Fig. 683.—CORFU.

The Wetlands Institute

This facility is a joint activity between The Wetlands Institute, incorporated as a nonprofit organization, and Lehigh University. The university operates the institute under its Center for Marine and Environmental Studies.

The Wetlands Institute, which commenced operations in 1972, is located on a 34-acre site on the edge of a coastal salt marsh near Stone Harbor, N.J. It is a research and teaching field station and, following the practice of other seaside marine research stations, educators and researchers from other colleges and universities may use the facilities for research and education which falls within the general objectives of the institute. These are as follows:

To increase the understanding of the natural processes controlling the wetlands ecosystems through fundamental research.

To investigate the renewability of the natural resources and to increase the biotic potential of the wetlands area.

To ascertain the effects of disturbances caused by man's activities, and to find methods of minimizing these effects through practical and applied research.

To provide factual scientific information which can serve others as a basis on which to make intelligent decisions for the long-range beneficial multiple use of coastal areas.

To train scientists and engineers in methods of solving and of preventing problems in the coastal zones.

To educate the general public, both resident and vacationing, in the importance of wetlands to the general ecology of coastal areas, to the need for preserving and for enhancing the wetlands in maintaining those aspects of the coastal zones that make them attractive to residents and vacationers, and what each person can do to protect the environment.

The Wetlands Institute provides facilities for year-round studies of the surrounding environment and includes six research laboratories, dormitory space and kitchen facilities, lecture room and demonstration area, flowing salt water system, maintenance shop, scientific laboratory equipment, and a variety of outboard motor skiffs.

Research activities

Current research interests of the institute staff include: salt marsh food webs; physiological criteria for determining sublethal effects of various environmental parameters; sedimentation studies; geochemistry of coastal salt marsh waters; beach sand studies; microbial mineralization of cellulose and chitin in salt marshes; new techniques for identification of planktonic fish eggs; viral diseases of fish; effect of sewage on marine organisms, and oil pollution studies.

Educational opportunities

Formal graduate studies are offered through the graduate programs in the various departments of the university.

One facet of graduate student training is related to preparation of scientists to continue studies of the coastal area; the other is concerned with providing school science teachers with sufficient training so that they are able to return to the classroom and pass on vital information about the tidal wetlands to their students.

In conjunction with teacher training, every effort is made to provide lectures, demonstrations and tours of the wetlands for classes. Selected undergraduate courses also are offered as part of the summer program. In addition, minicourses are offered during the year. These courses, which cover various aspects of the marine environment, may be taken for one unit of credit at Lehigh.

For further information, write to the director, Professor Sidney S. Herman, 217 Williams Hall, #31, Lehigh University, Bethlehem, Pennsylvania 18015.

Institute of Fracture and Solid Mechanics

The Institute of Fracture and Solid Mechanics was established in the fall of 1970 to enable faculty members and students within the university to participate in research relevant to fracture and solid mechanics on a unique, interdisciplinary basis.

An area of special interest to the institute has been in fracture mechanics which deals with the study of structural and material sensitivity to flaws. Such flaws can seriously affect the design and strength of ships, aircraft, automobiles, bridges and buildings. The design of nuclear power plants is required to incorporate the fracture mechanics concept of safety in the presence of flaws. In addition, fracture mechanics is finding application in such areas as bone fracture, environmentally accelerated cracking of pavements and structural members, the fracture of rocks, and erosion of materials by solid or water particle impingement.

The institute centralizes many activities in the field of solid and fracture mechanics. These activities include: expansion of research capabilities to include the application of concepts of fracture mechanics to geology (rocks), medicine (bones), and composite materials; editing books on timely subjects in fracture and solid mechanics; compilation and collection of written materials to establish and maintain a special library of fracture mechanics; planning of conferences on fracture and solid mechanics; offering short courses and seminars on special topics; conducting liaison programs with industry and government agencies.

Research activities

Currently, there are several research programs being conducted in solid and fracture mechanics. Sponsors of these programs are from industrial corporations and government agencies. The programs cover the following research topics:

Fracture mechanics. Analytical: stress analysis of engineering structures weakened by flaws; spherical and cylindrical shells with mechanical imperfections; crack extension in viscoelastic and rate sensitive materials; thermoelastic analysis of crack problems; heat generation at the crack tip region in metals; vibration and impact of solids containing cracks; three-dimensional analytical and finite element studies of surface and through cracks; fracture behavior of layered and fiber-reinforced composites; elastic-plastic solutions of crack problems.

Experimental: static and dynamic fracture toughness testing of metallic, non-metallic and composite materials; crack-extension resistance curve measurements for aluminum and titanium alloys and steels; glass-to-rubbery transition temperature in viscoelastic materials; velocity measurements of running cracks; fatigue crack propagation in pressurized shells and shells under membrane load; combined loading (biaxial, tension-bending, etc.) of thin plates with cracks; photoelastic studies of stress distribution in cracked and composite bodies; environmental effects on crack propagation under static cyclic loads; fatigue crack propagation under programmed loading; gaseous hydrogen embrittlement.

Solid mechanics. Analytical and numerical methods of analysis: conformal mapping technique applied to potential solutions; two- and three-dimensional asymptotic expansions near geometric discontinuities; integral transform solutions leading to Fredholm integral equations; singular integral equations with generalized Cauchy kernels; application of the Chebyshev and Jacobi polynomials; methods based on the Gauss-Jacobi quadrature formulas; special applications of numerical treatment and finite elements to continuum problems involving singularities; convergence of finite element solutions for continuum mechanics problems.

Plates and shells; development of advanced plate and shell theories; load-deflection and instability behavior of elastic and plastic shells of revolutions; composite and sandwich shells subjected to static and dynamic loadings; dynamics of magneto-elastic shells.

Educational opportunities

Students interested in fracture and solid mechanics should refer to course offerings in the departments of mechanical engineering and mechanics, metallurgy and materials science, civil engineering, chemistry and biology.

For further information write to the director, Professor George C. M. Sih, Packard Laboratory, #19, Lehigh University, Bethlehem, Pa. 18015.

RESEARCH ORGANIZATIONS

Fig. 433. — GREAT-HORNED OWL, (*Bubo Virginianus.*)

Bureau of Educational Service

The Bureau of Educational Service was organized in 1953 to provide professional assistance to public and private schools and various other educational groups.

Among the purposes of the bureau are the rendering of professional assistance to educational institutions by a cooperative study of their problems, fostering research in the field of educational practice, and helping to make the resources of the university more readily available to communities and agencies in need.

In fulfilling these purposes the bureau obtains the services of specialists from all areas of the academic profession.

Detailed information on assistance with specific problems can be secured from the director, Division of Educational Administration, School of Education, Lehigh University, 524 Brodhead Avenue, Bethlehem, Pennsylvania 18015.

Office of Research

The Lehigh Institute of Research was organized in 1924 to encourage and promote scientific research and scholarly achievement in every division of learning represented in the organization of the university, and in recognition of the need for further and more exact knowledge in science and in the application of science to the affairs of modern life.

The institute was reorganized in 1945 in recognition of the increasing role of government agencies and industry in sponsoring research, and renamed in 1968 in recognition of its administrative function.

Council for Research in Teaching and Learning

The University Council for Research in Teaching and Learning is an interdisciplinary effort to support the interests among groups of faculty members in research and development activities to enhance the teaching-learning process.

Formed as task forces, these groups pursue common interests in such areas as computer applications, educational technology, programmed learning, delinquent education, and many others.

A significant aspect of the council's work is that it encourages research and development activities relevant to the Lehigh community and to the educational community at large.

COURSE DESCRIPTIONS

General information

Following is a list of undergraduate and graduate courses offered by Lehigh University. For purposes of record, all approved courses are listed. It must be understood, however, that the offerings in any given semester are contingent upon a number of factors, including student needs as determined at the time of preregistration.

Credit hours

The number in parentheses following each course title indicates the credit value of the course in terms of semester hours. Three hours of drawing, of work in the laboratory, or of practice in the field are regarded as the equivalent of a recitation or lecture of one hour's duration.

Course numbering

The course numbering system specifies which courses can be applied to the program of study as the student progresses toward the undergraduate or graduate degree. In general, the numbering series is as follows:
0-99. Undergraduate courses, primarily for underclassmen. Not available for graduate credit.
100-199. Advanced undergraduate courses. Not open to freshmen except on petition. Not open to sophomores except on petition, unless part of major program or curriculum. Not available for graduate credit.
200-299. Courses open to advanced undergraduates and graduates. Not available for graduate credit in the major field.
300-399. Courses open to advanced undergraduates and graduates. Available for graduate credit in the major field.
400-499. Courses open to graduate students only, and undergraduates by special petition.

Provisional courses

Each instructional department is authorized to offer provisional courses—trial courses, high immediate relevance courses, and special opportunities courses—within a semester, with the option of having them become a permanent part of the university curriculum. These courses are numbered, as is appropriate, ... 97-98, ... 197-198, ... 297-298, ... 397-398, for a maximum of two semesters.

Students may take 97-98 courses pass/fail under the standard procedures for pass/fail.

Apprentice teaching

Apprentice teaching is designed for advanced students, normally in their senior year, who desire to learn about teaching under the guidance of an experienced teacher. Master and apprentice teachers are, with the approval of the department chairman in the area in which the apprentice teaching is to be done, free for the most part to work out whatever arrangements best fit the needs of the course.

Apprentices typically receive three hours of credit for attending classes, doing some lecturing or leading of discussion sections, assisting in making up or grading some written assignments and tests, and being available for some individual consultation with students. A student may register for apprentice teaching only once each semester, and only twice for credit during the college career, for a total of not more than six hours of credit. The student may register to be an apprentice teacher in a given course only once.

A graduate student who is not a paid teaching assistant may register for apprentice teaching, but the department decides whether the student may receive credit which will count toward fulfilling requirements for a graduate degree. The apprentice is graded for work in the course by the master teacher.

Students who wish to do apprentice teaching in extradepartmental courses, such as those offered as Freshman Seminars, may do so with the approval of the director of the program. In high immediate relevance courses or courses cross-listed in several departments, the approval of the chairman of the department in which the course is taught is required. In such cases, the student registers for the 300 course with the same heading as the course in which he or she is an apprentice (e.g., FS 300—Apprentice Teaching in FS 97C; HIR 300—Apprentice Teaching in HIR 197, or as a departmental 300 course if the HIR course is given as a departmental offering).

Prerequisites

Academic preparation required for admission to courses is indicated under "prerequisites" following course descriptions. Prerequisites are stated in most cases for purposes of convenience in terms of Lehigh courses. Status required for admission, where numbering does not fully describe this status, is also indicated under "prerequisites."

A student who does not have the status or the academic preparation set forth as prerequisites must, in order to be admitted to a course, file with the registrar at the time of registration and on a standard form provided by the registrar a waiver of prerequisites signed by the head of the teaching department, and the student's curriculum director. Academic work completed elsewhere must be attested in this manner as being substantially equivalent to prerequisites listed, unless the student's records in the office of the registrar show that the proper officers have so evaluated this preparation previously.

English 2, 10, 14 or 16 are prerequisites to all 100- or higher-level courses. Exceptions may be made only by petition to the committee on standing of students.

Abbreviations

Whenever possible, course listings contain information indicating what requirements the course satisfies, the semester or semesters in which it is offered, and the name of the scheduled instructor.

While all information herein is subject to change, the information is included to help guide the student in the selection of appropriate courses that best fulfill his or her academic and personal requirements.

The symbols following course titles for some College of Arts and Science courses include:

- **P** Courses that meet preliminary distribution requirements.
- **UP** Courses that meet upperclass or preliminary distribution requirements.
- **NS** Psychology department courses that meet the Natural Science distribution requirements.
- **SS** Psychology department courses that meet the Social Science distribution requirements.

Listing of instructor

Whenever possible, the name of the instructor scheduled to teach the course is included at the end of the course description. While every effort is made to have the designated instructor teach the course, no student should presume that substitutions will not be made as required. No instructor is listed in cases where several members of the staff may be chosen to teach the course, or where the instructor has not been designated.

Informational limits

The course descriptions provided below are intended to guide the student in selecting appropriate courses. For reasons of space, descriptions are brief. In most cases, courses will offer much more than the items listed in the description. In some courses, material may change from what is described. If there is doubt concerning the appropriateness of any course for the individual's educational objectives, it is advised that the student confer with the adviser.

ACCOUNTING

Professors. Carl L. Moore, M.A., C.P.A., chairman; Alfred P. Koch, M.S., C.P.A.; Robert H. Mills, Ph.D., C.P.A.; James B. Hobbs, D.B.A.

Associate professor. Feng-Shyang Luh, Ph.D.

Assistant professors. Dale R. Martin, Ph.D.; Kenneth P. Sinclair, Ph.D.; Stuart K. Webster, Ph.D., C.P.A.

Instructors. Dunham R. Bainbridge, M.S., C.P.A.; Albert F. Fries, Jr., M.B.A.; Robert W. Parry, Jr., M.B.A.; John W. Paul, M.B.A., C.P.A.

The course descriptions for Acctg 411 and Acctg 415 appear on page 218.

Major in the College of Business and Economics

Required: 15 credits beyond core requirements.

Acctg 315	Financial Accounting I (3)
Acctg 316	Financial Accounting II (3)
	accounting electives (except Acctg 390) (9)

Note: Students interested in qualifying for Certified Public Accountant or the Certificate of Management Accounting at either the bachelor or master of business administration level should consult the chairman of the department of accounting or their major adviser.

Undergraduate courses

51. Essentials of Accounting (3) fall-spring
The organization, measurement and interpretation of economic information. Introduction to accounting theory, concepts and principles, the accounting cycle, and information processing. Exposure to controversial issues concerning income determination and valuation. Prerequisite: sophomore standing.

52. Essentials of Accounting (3) fall-spring
Financial statement analysis for managerial and external use. The use of economic information for managerial planning and control. Introduction to job order, process, and standard cost accounting, variable costing and volume-mix-price-cost relationships. Prerequisite: Acctg 51.

108. Fundamentals of Accounting (3) fall-spring
A one-semester survey of accounting principles and practices, including an introduction to industrial cost systems designed for those students planning to take only one accounting course. Other students should take the Acctg 51, 52 sequence.

111. Computers in Business (3) fall-spring
An introduction to computers with emphasis on business applications. Develop a working knowledge of a computer language sufficient to solve business problems. Basic knowledge of hardware, software, error control, integrated systems, and simulation. Not open to students who have had a previous equivalent (normally three credit hours) course in computers.

For advanced undergraduates and graduates

300. Apprentice Teaching in Accounting (1-3)

307. Federal Tax Accounting (3) fall-spring
An interpretation of the federal income tax laws, rules, and regulations applicable to income tax determination of individuals, partnerships, and corporations. Tax planning and timing of transactions is emphasized. Prerequisite: Acctg 51 and 52. Mr. Koch.

311. Accounting Information Systems (3) fall
A general introduction to the development and implementation of an electronic data processing accounting information system. The course will consider the tools and techniques used by someone performing the systems function. Prerequisites: Acctg 52 and Acctg. 111. Mr. Luh.

315. Financial Accounting I (3) fall
Intensive study of the basic assumptions and principles of accounting, the accounting process, and problems concerned with presenting fairly the financial position and operating results of business entities. Consideration of the measurement of current assets, current liabilities, noncurrent assets, long-term debt, and preparation of financial statements. Prerequisites: Acctg 51 and 52. Messrs. Bainbridge and Webster.

316. Financial Accounting II (3) fall-spring
A study of generally accepted accounting principles and problems concerned with presenting fairly the operating results, financial position and changes in financial position of business entities. Consideration of shareholders, equity, partnerships, earnings per share, tax allocation, pensions, leases, and price level changes. Preparation, analysis, and interpretation of financial statements. Prerequisites: Acctg 51 and 52. Messrs. Bainbridge and Webster.

317. Advanced Accounting (3) spring
Problems of business combinations and consolidations, fund accounting as it applies to not-for-profit entities, foreign exchange, and fiduciary accounts. Prerequisite: Acctg 315 or 316. Mr. Luh.

320. Auditing (3) fall
Survey of auditing theory, objectives, and practices relating largely to the responsibilities of independent professional accountants; ethics of the profession, generally accepted auditing standards, internal control, examination of various systems including EDP, statistical methods, report writing, etc. Prerequisite: Acctg 315. Mr. Paul.

324. Cost Accounting (3) spring
Principles and practices of industrial cost accounting, including cost planning and budgeting, cost controls, job-lot and standard and process systems, variance analysis, performance reports, costs in management decisions. Prerequisite: Acctg 52.

371. Directed Readings (1-3)
Readings and research in various fields of accounting; designed for superior students who have a special interest in some topic or topics not covered by the regularly rostered courses. Written term paper(s) required. Prerequisite: preparation acceptable to department chairman.

372. Special Topics (1-3)
Special problems and issues in accounting for which no regularly scheduled coursework exists. When offered as group study, coverage will vary according to interests of instructor and students. Prerequisite: preparation in accounting acceptable to the department chairman.

390. Internship (3-6)
Designed to give advanced students of accounting, who have maintained a satisfactory standard of scholarship and who show promise in the field of accounting, an opportunity to acquire field experience and training with selected industrial or public accounting firms or governmental agencies as a complement to the academic learning process. Outside readings are assigned. Written reports are submitted by employer and students. The amount of credit is influenced by the length of the training period and the character of the experience afforded to the trainee, but does not exceed six hours for a regular semester or three hours for a summer period of at least eight weeks. Prerequisite: junior standing and approval of faculty committee on internship.

For Graduates

The specialized accounting courses at the 300 level are frequently offered in graduate sections in addition to the 400-level courses. These graduate offerings permit master of business administration students to take a limited concentration of nine to twelve hours in accounting. If they have taken twelve to fifteen hours in accounting as undergraduates, their total professional preparation of 21 to 27 hours represents a sound basis for a career in public, industrial or governmental accounting. Undergraduates may wish to plan ahead for a full five-year program including the master's degree for professional accounting preparation.

Note that Acctg 422, Managerial Accounting, is for MBA students majoring in a subject other than accounting and is not open for credit to master's candidates who majored in accounting as undergraduates or who are carrying an accounting field of specialization at the graduate level.

For further information about CPA requirements in different states, CMA certificate, or for the selection of accounting electives, see the chairman of the accounting department.

406. Advanced Tax Planning & Research (3) spring
An advanced course in federal tax laws, rules, and regulations involving cases and problems relating to various tax entities. Tax planning and utilization of research tools is emphasized. Prerequisite: Acctg 307. Mr. Koch.

408. (I.E. 408) Management Information Systems (3)
Integrated and total systems concepts for organizational data bases and information systems as applied to planning, development and implementation of computer-based management information systems. Emphasis placed on the interaction of information systems with management planning and control. Prerequisite: An advanced course in information systems and a knowledge of programming.

422. Managerial Accounting (3) fall
Survey course for non-accounting majors (related course for accounting majors is Acctg 324); uses of accounting data for managerial planning and control, including cost control; capital expenditure planning; product pricing decisions; operations research applications. Prerequisite: Acctg 51. Mr. Moore.

424. Advanced Management Accounting (3) spring
Managerial planning and control problems with emphasis on the responsibilities of the accountant. Practical applications using cases. Includes advanced treatment of management control systems, managed costs, transfer pricing, and the capital investment problem. Prerequisite: Acctg 324 or 422. Messrs. Luh and Sinclair.

426. Advanced Problems (3) spring
Advanced problems and cases in the formation, transfer of ownership interests, operation, and liquidation of various forms of business entities; government accounting; foreign exchange. Prerequisites: Acctg 315, 316 and permission of department chairman. Mr. Moore.

431. Accounting Theory and Thought (3) fall
A critical and historical examination of modern accounting concepts. Concerned with measuring enterprise income and capital and related economic data, in both simplified and realistic circumstances, and with communicating and interpreting such data effectively to interested parties. Prerequisite: 15 hours of accounting.

442. Professional Accounting Seminar (3)
spring, alternate years
Survey of technical and professional accounting problems at the advanced level. Advanced case studies in public accounting and management services. Prerequisite: 15 hours of accounting.

471. Directed Readings (1-3)
An extended study of an approved topic in the field of accounting. May be repeated.

472. Special Topics (1-3)
Special problems and issues in accounting for which no regularly scheduled coursework exists. When offered as group study, coverage will vary according to interests of instructor and students. Prerequisite: preparation in accounting acceptable to department chairman. May be repeated.

AEROSPACE STUDIES

Professor. Colonel Lawrence Hasbrouck, M.B.A., chairman.

Associate professors. Major Vincent A. Ziccardi, M.B.A.; Major Fred S. Deatherage, M.B.A.; Major Robert J. Schafer, M.A.Ed.

Assistant professor. Captain John H. Fergus, Jr., M.S.

The Air Force Reserve Officers Training Corps (AFROTC) program at Lehigh University was established in October, 1946. The program is conducted through the department of aerospace studies, which offers two voluntary programs for students to qualify for a commission as a second lieutenant in the Air Force: one of four years and one of two years.

Any student who will meet the baccalaureate degree requirements at the end of the university education may enroll in the four-year program or apply for entry into the two-year program. Students in the advanced Air Force ROTC courses receive a $100 monthly tax-free subsistence allowance. Students must complete their AFROTC training and university education and be commissioned by their thirtieth birthday.

The general objective of the Air Force program is to instill in each student: a basic understanding of associated professional knowledge; a strong sense of personal integrity and individual responsibility; an appreciation of the requirements of national security; and an opportunity to learn and develop leadership ability.

Course credit. Aerospace studies course credit may be substituted for six hours of electives for students in the College of Arts and Science and the College of Business and Economics. In the College of Engineering and Physical Sciences, six credits of advanced ROTC work will be included within the normal program of each student, irrespective of his or her curriculum. For curricula which include more than six hours of personal electives in the junior and senior years, inclusion of more than six hours of advanced ROTC credit within normal programs can be effected only with the approval of academic advisers.

Fig. 990.—WHITE-SHAFTED FANTAIL, (*Rhipidura arbiscapa.*)

Four-year program. The four-year program consists of classroom and laboratory work during the four undergraduate years and a field training period of four weeks, usually between the sophomore and junior years, at an airbase.

During the first two years, the program acquaints students with aerospace technological advances and current research and development activities. Students also begin leadership training. During the last two years, emphasis is placed on personal development. Students practice leadership talents and ability by assuming positions of responsibility in the Cadet Corps.

Two-year program. All requirements for commissioning can be completed in the two-year program. Students may apply for entry if they intend to complete two more full academic years — either undergraduate, graduate, or a combination of both. Prior to formal enrollment, each student successfully completes six weeks of field training at an Air Force base.

Scholarship program. Air Force ROTC awards scholarships at the freshman, sophomore and junior levels. They are available to qualified cadets in the two-year and four-year programs. Once awarded a scholarship, a cadet continues on scholarship status until graduation if all academic and military requirements are met. These scholarships cover full tuition, laboratory expenses, incidental fees, and books. Scholarship cadets also receive a $100 monthly tax-free subsistence allowance.

Flight instruction program. Senior cadets scheduled for pilot training take flight instruction in their senior year at no cost to themselves. The program provides twenty-five hours of flying time, seventeen hours dual and eight hours solo. Cadets who complete the instruction and go on to pass the Federal Aviation Administration written examination and the final flight check may receive an FAA private pilot's license.

Airborne training program. Appropriate classroom, physical conditioning, and airborne parachute training (including five controlled parachute jumps) is available through a cooperative Air Force-Army program. Aerospace studies students volunteering for this specialized course of instruction spend approximately three weeks at an active military installation during the summer preceding their senior year.

Field training. Two field training courses are offered. One course covers four weeks for cadets in the four-year program, and the other covers six weeks for two-year applicants.

Cadets normally attend the four-week course after their sophomore year. Candidates for the two-year program must successfully complete the six-week course before they enter the professional officer course.

The six-week course includes substantial classwork in the subject United States Military Forces in the Contemporary World. Both courses include orientation, survival training,

Fig. 1435. — A PRIEST AND GENTLEMAN.

junior officer training, aircraft, missile, aircrew-missile crew orientation, physical training, small arms marksmanship training, organization and function of an Air Force base, career orientation, and other supplemental training.

Travel pay is provided for those attending the field training courses. During their stay, Air Force ROTC applicants in the six-week course receive approximately $650, and those in the four-week course receive approximately $500. All cadets are provided with room and board while attending field training.

Eligibility requirements. To be eligible for the Air Force ROTC advanced program (final two years), or the scholarship program, a student must be: a citizen of the United States; physically qualified for commission in the Air Force in accordance with existing Air Force regulations; not under fourteen years of age and, upon graduation, not more than thirty years of age; planning to pursue work leading to at least a bachelor's degree; willing to sign a formal agreement and enlist in the Air Force Reserve at the beginning of the advanced course, usually at the start of the junior year or, upon initiation of a college scholarship obligating the person to remain in the ROTC program, to accept a commission and to serve the required period in the Air Force upon graduation.

Aerospace courses

21. Freshman Aerospace Studies (1) fall
A study of the doctrine, mission and organization of the U.S. Air Force; a study of tactical and airlift forces, their mission, function, and employment. Major Ziccardi.

22. Freshman Aerospace Studies (1) spring
A study of U.S. strategic offensive and defensive forces, aerospace support forces, and a review of Army, Navy and Marine general-purpose forces. Major Ziccardi.

23. Sophomore Aerospace Studies (1) fall
An examination of the developmental growth of airpower over the past seventy years by reviewing the various concepts of employment and focusing upon the factors which prompted research and technological change. Colonel Hasbrouck.

24. Sophomore Aerospace Studies (1) spring
A continuation of A.S. 23 with emphasis on a variety of events and elements in the history of airpower, especially where these provide significant examples of the impact of airpower on strategic thought. Colonel Hasbrouck.

113. The Professional Officer (3) fall
Concepts of Air Force leadership. A study of the meaning of professional responsibilities of the professional officer, the foundations of the military profession, the military justice system, theories of leadership, discipline and human relations. Captain Fergus.

114. The Professional Officer (3) spring
Concepts of Air Force management. Includes principles and functions of management, Air Force personnel policies, channels of communication, problem-solving, quantitative models and simulation, the command-staff team, the subordinate, performance standards, data processing, and Air Force controls. Captain Fergus.

115. American Defense Policy (3) fall
The executive-legislative matrix of our national government is developed and compared with other governmental systems. An analysis of the role and functions of professional military officers in a democratic society is stressed. Major Deatherage.

116. American Defense Policy (3) spring
Continued development of the fundamentals presented in A.S. 115 with special emphasis on the role of the junior officer in implementing national policy decisions. Integrated into this curriculum is the development of communicative skills necessary for today's military officer. Major Deatherage.

Leadership Laboratory
Each cadet participates a minimum of one hour per week during every semester of enrollment. Leadership Laboratory is scheduled at one time only, every Monday afternoon, for the entire cadet corps.

The objective is to provide a laboratory environment wherein each student receives an opportunity to learn and develop leadership and management abilities. Cadets plan, organize, and carry out the entire cadet group program with only minimal guidance from the staff advisers.

Cadets are promoted to cadet officer grades in the corps commensurate with their knowledge, experience, and demonstrated performance. Periodically, they move up the chain of command into positions of greater responsibility.

AMERICAN STUDIES

American Studies Committee

William G. Shade, Ph.D., professor of history and director of American Studies; James R. Frakes, Ph.D., Edmund W. Fairchild professor of American Studies; Joseph A. Dowling, Ph.D., distinguished professor of history; Lawrence H. Leder, Ph.D., professor of history; Peter G. Beidler, Ph.D., associate professor of English; and Edward J. Gallagher, Ph.D., associate professor of English.

This is an interdepartmental major emphasizing the idea that the institutions and values of a society comprise a whole and not merely a sum of separate parts. By concentrating on the unique expressions of individuals contained in the literature of America and by studying the historical movements within which these expressions develop, American Studies reveals relationships which may not be clearly seen within the framework of a single discipline.

By carefully choosing electives, the student can add to the insights of literature and history. Thus, for example, a student may pursue the relationship of the behavioral sciences to history and literature or use the various disciplines to give greater comprehension of the problems of the American city. In addition, the study in depth of one's own environment provides students with a greater awareness of the forces

which have shaped their world and their character and should produce a greater sensitivity to the values of their own society.

The major consists of sequences in American history and literature, followed by twelve hours of advanced study divided equally between American history and American literature, six hours of electives in any aspect of the American experience and six hours of either European literature or European history. In the senior year, the student takes one history and one literature seminar organized around a single theme in each respective field. The major requirements total 44 hours.

Because the emphasis is strongly placed on American history and literature, an undergraduate American Studies major will provide thorough preparation for graduate work in American Studies and, with suitable collateral courses, American literature or American history. In addition, the major may help in preparing students for advanced work in law, theology, and teaching in secondary schools and community colleges.

Required preliminary courses

Hist 9	Formation of American Society (4)
Hist 10	American Society in the Industrial Era (4)
Engl 23	Survey of American Literature (3)
Engl 24	Survey of American Literature (3)

Required upperclass courses

Six credit hours to be chosen from each of the following groups.

Engl 376	Early American Literature (3)
Engl 377	American Romanticism (3)
Engl 378	American Realism (3)
Engl 379	Twentieth Century American Literature (3)
Engl 380	Contemporary American Literature (3)

Hist 119	Colonial America (3)
Hist 120	Revolutionary America (3)
Hist 325	American Social History (3)
Hist 326	American Social History (3)
Hist 327	American Intellectual History (3)
Hist 328	American Intellectual History (3)

Required senior seminars

Engl 382	Themes in American Literature (3)
Hist 374	Themes in American History (3)

Electives

A Non-American Field (6)
An American Field (6)

Choice of electives is made in consultation with the adviser. The student is encouraged to select courses from such disciplines as fine arts, government, modern foreign languages, philosophy, religion studies, social relations and urban studies.

Admission to honors in American Studies is by invitation of the committee in the student's junior year. The student must attain an average of 3.2 in major courses, in addition to the university honors requirements.

ARTS–ENGINEERING

G. Mark Ellis, Ph.D. associate dean, College of Arts and Science, curriculum director.

The standard major for arts-engineers working towards a bachelor of science degree is applied science. This includes all of the science and engineering courses required in the freshman year and included in the pattern roster for the chosen field of engineering.

Arts-engineers with special interests outside engineering frequently combine another arts or science major with their engineering program. Interested students should consult with the curriculum director.

Recommended freshman year

Arts-engineering freshmen have the same roster of courses as do engineering freshmen, with the exception that the arts-engineering freshman takes Economics 1 the second semester in place of an elective. Refer to the recommended freshman year, College of Engineering and Physical Sciences.

Recommended professional sequences

Beginning with the sophomore year, the arts-engineering student will be guided by the appropriate pattern roster in the chosen field. The pattern roster shows the most effective way of combining arts and engineering courses to prepare for the last year in the branch of engineering chosen.

Although the minimum number of credit hours needed for the bachelor of arts degree is 120, a student in arts-engineering should expect to earn more than this in order to qualify for the bachelor of science degree in the chosen field of engineering at the end of the fifth year. The number needed for both degrees is shown for each pattern roster.

Arts-Chemical Engineering

157 credit hours needed for the bachelor of arts and bachelor of science degrees.

sophomore year, first semester (16 credit hours)

Math 23	Analytic Geometry and Calculus III (4
ChE 31	Equilibria (3)
ChE 41	Cascade Processing Concepts (3)
	distribution electives (6)

sophomore year, second semester (15 credit hours)

Math 205	Linear Methods (3)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Lab II (1)
ChE 52	Introduction to Transport Phenomena (4)
	distribution elective (3)

junior year, first semester (16 credit hours)

Chem 51	Organic Chemistry (3)
Chem 53	Organic Chemistry Lab (1)
Chem 187	Thermodynamics (3)
ChE 167	Unit Operations (3)
	distribution elective (6)

junior year, second semester (14 credit hours)

Chem 191	Physical Chemistry (3)
Chem 192	Physical Chemistry Lab (2)
ChE 286	Modeling, Simulation and Control (3)
	distribution elective (3)
	elective (3)

senior year, first semester (15 credit hours)

	electives for engineering major (6)
	distribution electives (6)
	elective (3)

senior year, second semester (14 credit hours)

ChE 169	Unit Operations Lab (1)
ChE 210	Chemical Engineering Thermodynamics (4)
	elective for engineering major (3)
	distribution electives (6)

summer

ChE 100	Industrial Employment

Note: For senior year engineering electives, the student should consult with department of chemical engineering advisers.

Arts-Civil Engineering

162 credit hours needed for the bachelor of arts and bachelor of science degrees.

sophomore year, first semester (15 credit hours)

Math 23	Analytical Geometry and Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Lab II (1)
	distribution electives (6)

sophomore year, 2d semester (15 credit hours)

Math	Approved Mathematics Elective (3)
Mech 1	Statics (3)
	distribution electives (6)
	elective (3)

junior year, first semester (15 credit hours)

Mech 11	Mechanics of Materials (3)
CE 9	Civil Engineering Computations (1)
CE 11	Engineering Graphics (2)
	distribution electives (9)

junior year, second semester (15 credit hours)

Met 92	Structure and Properities of Materials (3)
CE 40	Principles of Surveying (3)
	distribution electives (9)

summer (3 credit hours)

CE 41	Engineering Surveys (3)

senior year, first semester (17 credit hours)

CE 109	Numerical Techniques (2)
CE 121	Mechanics of Fluids (3)
CE 143	Soil Mechanics (3)
CE 159	Structural Analysis (3)
	electives (6)*

senior year, second semester (15 credit hours)

Mech 104	Dynamics and Vibrations (3)
CE 160	Structural Design (3)
CE 170	Environmental Engineering (3)
CE 222	Hydraulic Engineering (3)
	elective (3)*

summer

CE 100 Summer Employment
Eight weeks of summer employment should precede fifth year. Consult the chairman of the department.

* Electives which require approval of the civil engineering department.

Arts-Computer Engineering

156 credit hours needed for the bachelor of science and bachelor of arts degrees.

sophomore year, first semester (15 credit hours)

Math 23 Analytical Geometry and Calculus III (4)
Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Lab II (1)
distribution electives (6)

sophomore year, 2d semester (15 credit hours)

EE 141 Switching Theory and Logic Design (3)
Math 205 Linear Methods (3)
distribution electives (3)
electives (6)

junior year, first semester (15 credit hours)

EE 11 Principles of Computing Techniques (3)
Math 231 Statistical Inference or
Math 309 Theory of Probability (3)
distribution electives (9)

junior year, second semester (16 credit hours)

EE 20 Introduction to Circuit Theory (4)
science elective (3)*
distribution electives (9)

senior year, first semester (14 credit hours)

EE 105 Electronic Circuits (4)
EE 104 Linear Systems and Signals (4)
approved elective (3)*
distribution elective (3)

senior year, second semester (14 credit hours)

EE 201 Computer Architecture (3)
EE 315 Principles of Computer Software (3)
EE 317 Analytical Methods for Information Sciences (3)
EE 142 Junior Lab (2)
approved elective (3)*

summer

EE 100 Industrial Employment

* Electives which require approval of the department of electrical engineering.

Arts-Electrical Engineering

157 credit hours needed for the bachelor of arts and bachelor of science degrees.

sophomore year, first semester (15 credit hours)

Math 23 Analytical Geometry and Calculus III (4)
Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Lab II (1)
distribution electives (6)

sophomore year, 2d semester (16 credit hours)

Math 205 Linear Methods (3)
Mech 103 Principles of Mechanics (4)
distribution elective (3)
electives (6)

junior year, first semester (15 credit hours)

EE 11 Principles of Computing Techniques (3)
Math 231 Statistical Inference or
Math 309 Theory of Probability (3)
distribution electives (9)

junior year, second semester (16 credit hours)

EE 20 Introduction to Circuit Theory (4)
science elective (3)
distribution electives (9)

senior year, first semester (14 credit hours)

EE 105 Electronic Circuits (4)
EE 104 Linear Systems and Signals (4)
approved elective (3)*
distribution elective (3)

senior year, second semester (14 credit hours)

EE 103 Physical Electronics (3)
EE 236 Electromagnetic Fields I (3)
EE 106 Electromechanics and Machines (3)
EE 142 Junior Lab (2)
approved elective (3)

summer

EE 100 Industrial Employment

*Electives which require approval of the department of electrical engineering.

Note: Students must choose at least one elective in mathematics and at least one elective in materials, thermodynamics, fluid mechanics, or physical chemistry by the end of the above-mentioned senior year, second semester.

Arts-Engineering Physics

158 credit hours needed for the bachelor of arts and bachelor of science degrees.

Arts-engineering physics students complete, during the first four years, the physics major under the guidance of the chairman of the department of physics.

Arts-Industrial Engineering

159 credit hours needed for the bachelor of arts and bachelor of science degrees.

sophomore year, first semester (15 credit hours)

Math 23 Analytic Geometry and Calculus III (4
Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Lab II (1)
IE 5 Industrial Organization Models (3)
distribution elective (3)

sophomore year, 2d semester (15 credit hours)

IE 110 Engineering Probability (3)
IE 18 Data Processing Fundamentals (3)
engineering science elective (3)
distribution electives (6)

junior year, first semester (15 credit hours)

Math 205 Linear Methods (3)
IE 205 Engineering Statistics (3)
engineering science elective (3)
distribution electives (6)

junior year, second semester (16 credit hours)

IE 206 Operation Research Techniques (4)
engineering science elective (3)
distribution electives (6)
elective (3)

senior year, first semester (16 credit hours)

IE 101 Fundamentals of Manufacturing Engineering (4)
engineering science elective (3)
distribution electives (9)

senior year, second semester (15 credit hours)

IE 102 Work Systems (3)
engineering science electives (6)
electives (6)

summer

IE 100 Industrial employment should precede fifth year. Consult chairman of the department of industrial engineering.

Note: Engineering science electives must be cleared with the department of industrial engineering.

Arts-Mechanical Engineering and Mechanics

158 credit hours needed for the bachelor of arts and bachelor of science degrees.

sophomore year, first semester (17 credit hours)

Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Lab II (1)
Math 23 Analytical Geometry and Calculus III (4)
ME 12 Engineering Drawing and Descriptive Geometry (2)
distribution electives (6)

sophomore year, second semester (15 credits)

Mech 1 Statics (3)
Math 205 Linear Methods (3)
ME 104 Thermodynamics (3)
distribution elective (3)
elective (3)

junior year, first semester (15 credit hours)

Met 63 Engineering Materials and Processes (3) or
Met 91 Elements of Materials Science (3)
Mech 11 Mechanics of Materials (3)
distribution electives (9)

junior year, second semester (15 credit hours)

Mech 102 Dynamics (3)
ME 21 Mechanics Engineering Laboratory I (1)
ME 231 Fluid Mechanics (3)
EE 160 Electrical Circuits and Apparatus (4)
EE 162 Dynamo Laboratory (1)
elective (3)

senior year, first semester (15 credit hours)

ME 105 Thermodynamics II or Approved Elective (3)
Math 208 Complex Variables or
Math 231 Statistical Inference (3)
Mech 203 Advanced Strength of Materials (3)
distribution electives (6)

senior year, second semester (17 credit hours)

ME 101 Mechanical Engineering Design (1)
ME 151 Mechanical Elements or Approved Elective (3)
ME 242 Mechanical Vibrations (3)
CE 123 Fluid Mechanics Laboratory (1)
distribution electives (6)
elective (3)

summer

ME 100	Summer employment should precede the fifth year. Consult the chairman of the department of mechanical engineering and mechanics.

Arts-Metallurgy and Materials Science

159-161 credit hours needed for the bachelor of arts and bachelor of science degrees, depending on option selected.

sophomore year, first semester (15 credit hours)

Met 63	Engineering Materials and Processes or
Met 91	Elements of Materials Science (3)
Math 23	Analytic Geometry and Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Lab II (1)
	distribution elective (3)

sophomore year, second semester (16-17 credits)

Met 10	Metallurgy Laboratory (1)
Mech 1	Statics (3)
EE 160	Electrical Circuits and Apparatus or
Phys 31	Introduction to Quantum Mechanics (3-4)
	distribution elective (6)
	elective (3)

junior year, first semester (15 credit hours)

Met 207	Electron and Crystal Structure (3)
Met 210	Metallurgical Thermodynamics (3)
Mech 11	Mechanics of Materials (3)
ChE 60	Engineering in Chemical Manufacturing (3)
	distribution elective (3)

junior year, second semester (15 credit hours)

Met 208	Phase Diagram and Transformations (3)
Met 218	Mechanical Behavior of Materials (3)
	distribution electives (9)

senior year, first semester (15 credit hours)

Met 307	Structure and Behavior of Materials (3)
Math 205	Linear Methods or
Math 231	Statistical Inference (3)
	distribution electives (6)
	electives (3)

senior year, second semester (16-17 credit hours)

ME 166	Procedures for Mechanical Design or
Mech 102	Dynamics (2-3)
Met 304	Extractive Metallurgy I (4)
Met 101	Professional Development (1)
	distribution electives (6)
	electives (3)

summer

Met 100	Industrial employment should precede the fifth year. Consult the chairman of the department.

Note: students interested in the industrial or research option should consult with the department chairman prior to their fourth year. Students selecting the research option should elect Met 240, Research Techniques, in the second semester of the senior year.

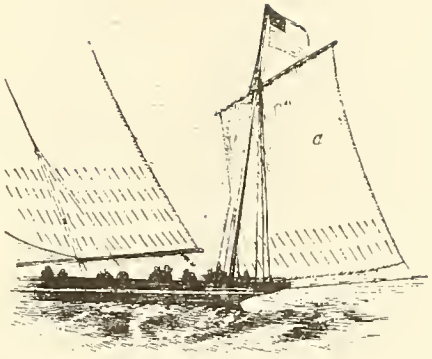

Fig. 875. — *a*, THE DRIVER.

ATHLETICS AND RECREATION

Professor. William B. Leckonby, B.S., director

Associate professor. John S. Steckbeck, M.Sc.

Assistant professors. John N. Covert, B.S.; Gerald G. Leeman, B.A.; Anthony Packer, B.S.; B. Thayer Turner, B.S.

Instructors. N. Craig Anderson, M.S., business manager; Helen Bond, B.S.; Barbara Lipkin, B.Sc.; Bruce Gardiner, M.Sc.; Brian Hill, B.A.; John L. Luckhart, M.Sc.; Charles R. McNaron, B.S.; Samson L. Sanders, M.Ed.; Stanley R. Schultz, B.A.; and John C. Whitehead, B.S.

The department of intercollegiate athletics and the department of recreation and intramural sports supervise the entire field of intercollegiate athletics, recreation and intramurals at the university. Activities consist of intercollegiate athletics, recreation, and intramural sports, including corrective exercises.

Experience indicates that it is essential that the intramural and recreation programs emphasize the physical fitness and efficiency benefits to be derived from a well-rounded sports phase of the program. The athletic, recreation and intramural sports program is designed to: raise and maintain the physical standards of the university; develop and maintain a high level of all-round physical fitness so that undergraduate men and women may more readily assimilate instruction; encourage regular and healthful exercise by the development of skills, techniques, and attitudes; foster an aggressive and cooperative team spirit, to increase the confidence of the individual, to develop sportsmanship, and to increase university pride through participation in vigorous competitive athletics.

Facilities are afforded in Taylor Gymnasium, Grace Hall, Taylor Field, and Sayre Park Field, the latter an area of seven acres located above the Lookout on top of South Mountain and only a short distance from fraternity houses and residence halls. Saucon Valley Fields are located south of the campus. The 478 acres there accommodate the following facilities: all-weather quarter-mile track, nine all-weather tennis courts, lacrosse and soccer fields, three football practice fields, Varsity House, two baseball diamonds, twelve to sixteen intramural fields, and a football field. The area is the site of a future athletics and convocation center that will seat 6,000. Almost all of the outdoor intramural sports contests and all upperclass intramural activities are held in the Saucon Valley area; a shuttle bus service is provided to and from this field.

The Saucon Valley athletic complex, in addition to the aforementioned Varsity House, also features recently constructed indoor squash courts. A new 60,000-square-foot fieldhouse includes an indoor track, tennis courts, volleyball courts and basketball courts. An additional baseball diamond also has been completed in this area.

Department of Intercollegiate Athletics

The department of intercollegiate athletics offers opportunity to undergraduate men and women to participate in intercollegiate competition both at home and away with institutions which are Lehigh's traditional rivals and also other institutions which are at some distance.

The intercollegiate program consists of varsity teams in football, cross country, soccer, wrestling, basketball, swimming, tennis, track, baseball, golf, lacrosse, hockey, squash, winter track, and rifle. In addition, there are junior varsity and/or freshman teams in some of the above.

Recently, a women's athletic program has been inaugurated. Lehigh now competes at the intercollegiate level with other colleges in field hockey, volleyball, basketball, swimming, tennis and lacrosse.

Department of Intramural Sports and Recreation

The department has supervision and control of the intramural sports and the recreational physical activities of the student body. The aim is to insure the health and physical development of every student.

Through its program of intramural sports, the university endeavors to maintain among its students a high degree of physical fitness, to establish habits of regular and healthful exercise, to foster the development of such valuable byproducts as self-confidence, good sportsmanship, and a spirit of cooperation, and to provide each student with ample opportunity for acquiring an adequate degree of skill in sports of the type in which participation can be continued after graduation.

Prior to his or her arrival on campus, each new or transfer student must submit to the Health Service a record of physical examination filled in and signed by a physician, and a completed health history form. All such forms are carefully checked by the Health Service and each student thereby classified for activities in the department of physical education in accordance with his or her current health status.*

A wide variety of instruction courses are available on a voluntary basis. Courses stress the history, rules, fundamentals and playing situations and are taught on an elective basis. Corecreation (for men and women simultaneously) opportunities are available. Instruction and competition for women students are available in a number of activities. Individual sports are offered on a voluntary basis.

In the gymnasium, opportunity is offered in the following activities: recreational swimming, beginners swimming, dance, physical development, boxing, apparatus exercises, life-saving, controlled weight training, badminton, judo, karate, and sports fundamentals.

A comprehensive program in intramural sports is sponsored for the student body including fraternity, residence hall, interclass, town, and independent groups in touch football, tennis, soccer, badminton, handball, individual athletics, basketball, swimming, wrestling, track, softball, squash, volleyball, and recreative games. Students are encouraged to participate in these sports, and awards are given for excellence in performance.

The university maintains a well-equipped Health Service for medical treatment. If a student is injured while engaged in any sport he must report as soon as possible to the first-aid room or to the Health Service located in Johnson Hall.

Instruction opportunities

The following programs and activities are open to all Lehigh students.

nonswimmers' program, basic swimming, senior life saving, water safety instruction, scuba diving (fee), fencing, bowling, golf, basic tennis, intermediate tennis, advanced tennis, modern dance, horsemanship (fee), physical fitness, personal defense (fee), stunts and tumbling, basketball, volleyball, softball, squash, handball, paddle ball, running, skating (fee), and skiing (fee).

No credit is given for these courses; they are voluntarily elected subject to permission of the instructor. A periodic announcement is made.

*All students in order to compete in intercollegiate activities must sign up for the student insurance program or have his or her own insurance program which covers athletic injuries.

Fig. 1502. — A LAMELLICORN. The Stag-Beetle, (*Lucanus cervus.*)

BIOLOGY

Professors. Saul B. Barber, Ph.D., associate dean, College of Arts and Science; Sidney S. Herman, Ph.D., director, The Wetlands Institute; Richard G. Malsberger, Ph.D.

Associate professors. Steven Krawiec, Ph.D., chairman; Hayden N. Pritchard, Ph.D.

Assistant professors. Barry Bean, Ph.D.; David Bell, Ph.D.; Patricia Bradt, Ph.D.; David Cundall, Ph.D.; and K. Elaine Hoagland, Ph.D.

The biology department offers students a choice of two majors, the bachelor of arts in biology and the bachelor of science in biology. The principal differences in requirements for the two majors are:

1. The bachelor of arts course of study requires the student to complete the distribution requirements of the College of Arts and Science in addition to the requirements of the biology major.

2. The bachelor of science course of study requires that, in addition to the requirements of the biology major, the student complete a total of thirty-one hours with the only elective restriction being that they be outside the fields of natural science and mathematics.

3. The bachelor of arts curriculum has a total of sixty-two hours of courses in the major requirements as compared to eighty-three in the bachelor of science curriculum.

The bachelor of arts major in biology is not designed specifically for preprofessional training but it does exceed the minimum requirements for admission to medical, dental and allied professional colleges as well as to study for

advanced degrees in most of the fields of graduate biology. It is, therefore, recommended to those students who desire an adequate background in biology combined with the cultural background of the arts college distribution requirements.

The bachelor of science major in biology is designed specifically for optimal scientific preparation for entry into professional graduate training in medicine, dentistry and allied professional fields as well as in graduate biology. Such preprofessional training is obtained at the cost of a reduction in the number of nonscience courses a student will be able to take during a normal four-year undergraduate program. Students should, therefore, consider carefully before committing themselves to either program. An initial choice of one or the other program is revisable, although this becomes more difficult after the freshman year.

Students also may apply for acceptance in one of the two six-year B.A.-M.D. programs offered in cooperation with two Philadelphia medical schools. The Lehigh University bachelor of arts requirements with a major in biology are completed and the M.D. requirements of one of the cooperating medical schools are also completed, both within a six-year period. For details of both programs students should consult the section on Health Professions, page 29.

Bachelor of Arts major

required courses in biology

Biol 21	Principles of Biology (3)
Biol 22	Introduction to Biology Laboratory (1)
Biol 28	Genetics (3)

plus six hours from each of the categories listed below; plus a three-hour elective chosen from any category. The selection of courses must include either Biol 331 or Biol 332.

Category I

Biol 34	Comparative Vertebrate Anatomy (4)
Biol 303	Invertebrate Zoology (3)
Biol 313	General Histology (3)
Biol 314	Vertebrate Embryology (3)
Biol 322	Animal Physiology (3)
Biol 329	Herpetology (3)
Biol 331	Non-vascular Plants (3)
Biol 332	Evolution of Vascular Plants (3)
Biol 333	Symbiosis (3)

Category II

Biol 306	Ecology (3)
Biol 309	Aquatic Biology (3)
Biol 317	Evolution (3)
Biol 324	Animal Behavior (3)
Biol 331	Nonvascular Plants (3)
Biol 333	Symbiosis (3)
Biol 361	Sanitary Microbiology (3)

Category III

Biol 35	Microbiology (3)
Biol 313	General Histology (3)
Biol 320	Cell Physiology (3)
Biol 322	Animal Physiology (3)
Biol 325	Advanced Genetics (3)
Biol 327	Regulatory Biology (3)
Biol 353	Virology (3)
Biol 371	Elements of Biochemistry I (3)
Biol 372	Elements of Biochemistry II (3)

Cognate courses in other departments (e.g., Psych 375, Physiological Psychology, Phys 367, Introduction to Molecular Biophysics, and Phys 368, Molecular Biophysics) will be assigned to a category by the major adviser. Biol 341, Biology of Marine Animals (6), satisfies three hours in Category I and three hours in Category II.

Additional required courses

Math 41	BMSS Calculus (3)
Math 42	BMSS Probability (3)
Math 43	BMSS Linear Algebra (3)
Chem 21, 22	Chemical Principles & Laboratory (5)
Chem 51, 52, 55	Organic Chemistry & Laboratory (8)
Chem 39	Analytical Chemistry or
Chem 31	Chemical Equilibria in Aqueous Systems or
Chem 194	Physical Chemistry (3)
Phys 11, 12	Introductory Physics and Laboratory (5)
Phys 13, 14	General Physics and Physics Laboratory (4)

recommended sequence of science courses

freshman year

Biol 21	Principles of Biology (3)
Biol 22	Introduction to Biology Laboratory (1)
Biol 28	Genetics (3)
Chem 21	Chemical Principles I (4)
Chem 22	Chemical Principles I Laboratory (1)
Math 41	BMSS Calculus (3)
Math 42	BMSS Probability (3)

sophomore year

Chem 51, 52	Organic Chemistry (6)
Chem 55	Organic Chemistry Laboratory (2)
Math 43	BMSS Linear Algebra (3)
Biol	electives (3 or 6)

junior year

Phys 11, 12	Introductory Physics and Lab (5)
Phys 13, 14	General Physics and Lab (4)
Biol	electives (3, 6, or 9)

senior year

Chem 39	Analytical Chemistry or
Chem 31	Chemical Equilibria or
Chem 194	Physical Chemistry (3)
Biol	electives (3, 6, or 9)

Bachelor of Science major

required courses in biology

Biol 21	Principles of Biology (3)
Biol 22	Introduction to Biology Lab (1)
Biol 28	Genetics (3)

plus nine hours from each of the three categories listed above. The selection of courses must include Biol 331 or Biol 332.

additional required courses

Math 21, 22, 23	Analytic Geometry and Calculus (12) or
Math 41, 42, 43, 44	BMSS Calculus, Probability and Linear Algebra (12)
Chem 21	Introductory Chemical Principles (4)
Chem 22	Chemical Principles Lab (1)
Chem 51, 52	Organic Chemistry (6)
Chem 55	Organic Chemistry Lab (2)
Chem 31	Chemical Equilibria (3)
Chem 187 or 194	Physical Chemistry (3)
Phys 11	Introductory Physics I (4)
Phys 12	Introductory Physics Lab I (1)
Phys 13	General Physics (3)
Phys 14	General Physics Laboratory (1)
Geol 1	Principles of Geology (3)

and one of the following:

Psych 1	Introduction to Psychology (3)
Psych 109	Statistical Analysis (3)
Phil 261	Philosophy of the Natural Sciences (3)

and 31 hours of non-science electives.

recommended sequence of science courses

freshman year

Biol 21, 22	Principles of Biology and Lab (4)
Biol 28	Genetics (3)
Math 21, 22	Analytical Geometry and Calculus I, II (8) or
Math 41, 42	BMSS Calculus and Probability (6)
Chem 21, 22	Chemical Principles I and Lab (5)

sophomore year

Chem 51, 52, 55	Organic Chemistry and Lab (8)
Math 23	Analytic Geometry and Calculus III (4) or
Math 43, 44	Calculus and Linear Algebra (6)
Chem 31	Chemical Equilibria (3)
Biol	electives (6)
Psych	elective (3) or
Phil	elective (3)

junior year

Geol 1	Principles of Geology (3)
Phys 11, 12	Introductory Physics I and Lab (5)
Phys 13, 14	General Physics and Lab (4)
Psych	elective (3) or
Phil	elective (3)
Biol	electives (6-12)

senior year

Chem 187 or 194	Physical Chemistry (3)
Biol	electives (6-12)

Biology minor

A minor in biology may be achieved by completing the following requirements:

Biol 21, 22	Principles of Biology and Lab (4)
Biol	electives (12)
Chem 21, 22	Chemical Principles and Lab (5)
Chem 51	Organic Chemistry (3)
Phys 11, 12	Introductory Physics and Lab (5)
Math 41	BMSS Calculus (3)

total credits 32

Undergraduate Courses

1. Biology and Society (3)
Principles and implications of modern biological thought for non-science, business, and engineering majors. Areas of high social relevance, such as genetics, behavior, pop-

ulations, and environment. May mot be substituted for or taken in addition to Biol 21.

21. Principles of Biology (3) fall-spring
Introduction to biology by study of selected principles. Topics covered include cell structure and function, plant and animal structure and function, diversity and evolution of organisms. Three lectures per week.

22. Introduction to Biology Laboratory (1) fall-spring
Laboratory observations and experiments to illustrate how biological information is acquired. Designed primarily as a laboratory to accompany Biol 21. Prerequisite: Biol 21 previously or concurrently. One three-hour laboratory per week. Graded only pass-fail.

28. Genetics (3) fall-spring
Organization, replication, and transmission of hereditary information. Mechanisms of expression and modification of genes.

34. Comparative Vertebrate Anatomy (4) fall
A course in vertebrate zoology with emphasis on the study of homologous body structures in the various vertebrate classes and their relationship to the functional demands of habit and environment in each class. Detailed dissections of representative vertebrates are made in the laboratory. Two lectures and two laboratory periods. Prerequisites: Biol 21 and 22, or equivalent: sophomore standing. Mr. Cundall.

35. Microbiology (3) fall-spring
The appearance, physiology, and taxonomy of prokaryotes. Two lectures and one laboratory period. Prerequisite: Chem 52, previously or concurrently.

191. (Geol 191) Environmental Science Seminar (3)
Seminar on current problems and developments in environmental science. May be repeated for credit. Prerequisite: sophomore standing. Messrs. Evenson and Bell.

For advanced undergraduates and graduates

221. Undergraduate Research (3)
Laboratory work, field work, or both depending upon the interest and competence of the student. Prerequisites: junior standing and consent of department chairman.

231. Natural History and Ecology (3) summer session
A concentrated course in recognition of species of plants and animals and study of their interrelationships in natural and altered environments. Lectures and seminars in use of keys and preservation of collections. Designed for secondary school teachers in life sciences. Prerequisites: graduate standing or consent of department chairman.

232. Natural History and Ecology Workshop (3)
Field and laboratory work in natural history and ecology. Must be taken concurrently with Biol 231.

241. Ecology of Wetlands (6) summer
Study of plants and animals of wetlands areas and their interrelationships with the environment. The importance of the wetlands to the marine environment and methods of conservation. Independent study will form part of the course. Primarily designed for secondary school teachers of the sciences. Prerequisite: consent of department chairman. (Offered only at The Wetlands Institute.)

261. Special Topics in Biology (1-3)
Research, conferences, and reports on selected topics not covered in the general undergraduate offerings. May be taken more than once for credit. Prerequisite: consent of department chairman.

262. Special Topics in Biology (1-3)
Continuation of Biol 261.

303. Invertebrate Zoology (3) spring
Detailed survey of representative invertebrates. Anatomical and histological examination of selected types. Concepts of evolution and speciation. Two lectures and one laboratory. Prerequisite: two semesters of biology, one with laboratory.

306. Ecology (3) fall-spring
Basic principles of ecological interrelationships from a systems analysis perspective. Examination of ecological phenomena at the individual, population, community, and ecosystem levels. Two lectures and one laboratory period or field trip. Prerequisite: two semesters of biology, one with laboratory.

309. Aquatic Biology (3) alternate years
Lectures on the physical, chemical and biological aspects of the fresh water environment including cyclic and seasonal changes. A consideration of the major groups of organisms and their interactions. Influence of manmade alterations including impoundments and waste disposal methods. Two lectures and one laboratory period or field trip. Prerequisites: Biol 21, 22 or equivalent. Mr. Bell.

313. General Histology (3) spring
The techniques of preservation and preparation of animal and plant tissues for microscopical study; comparative studies of fresh and preserved tissues. One lecture and two laboratory periods. Prerequisite: Biol 21 and 22 or equivalent; Biol 34 or equivalent recommended. Mr. Cundall.

314. Vertebrate Embryology (3) spring
A study of reproduction from germ cell formation through establishment of the principal organ systems of the vertebrate body. Various mechanical and physiological problems confronting the growing embryo are considered, and direct observation of whole mounts, sections, and living material are made in the laboratory. Two lectures and one laboratory period. Prerequisite: Biol 34 or equivalent. Mr. Cundall.

317. Evolution (3) spring
Mechanisms of evolution, emphasizing natural selection, genetic structure and variation of populations, and isolation. Origin of species and higher taxa. Rates of evolution, extinction. Prerequisite: Biol 28 and an additional semester of biology, or consent of chairman.

320. Cell Physiology (3) fall
The fundamental processes of life at the cellular level, including permeability and related membrane phenomena, enzymatic transformations, respiration, photosynthesis, gene function, bioelectricity, and other aspects of neuron function, contractility and other kinds of protoplasmic motility. Two lectures and one laboratory. Prerequisites: two semesters of biology, at least one with laboratory, Chem 52, or consent of department chairman.

322. Animal Physiology (3) spring
The physiology of organs and organ systems in animals. Emphasis on mammalian systems, but lower vertebrates and invertebrates are also included. Functions studied include digestion, nutrition, metabolism, excretion, respiration, circulation, locomotion, nervous and chemical coordination. Two lectures and one laboratory. Prerequisites: two semesters of biology, at least one with laboratory. Chem 52 or consent of department chairman.

324. Animal Behavior (3) spring
Discussion of the behavior of invertebrates and vertebrates and analysis of the physiological mechanisms responsible for behavioral actions. Emphasis on perception, environmental stimuli, and adaptive value of specific behavior patterns. Prerequisite: Biol 21 or consent of department chairman. Mr. Bell.

325. Advanced Genetics (3) fall
Lectures and student contributions on selected aspects of genetics, with emphasis on the molecular approach. The structure, organization, and replication of genes. The expression of genetic information and its regulation in cellular and developmental biology. Prerequisite: Biol 28 or consent of department chairman. Mr. Bean.

327. Regulatory Biology (3)
Survey of biological regulatory systems and their mechanisms of operation at the biochemical, subcellar, cellular, and organismic levels. Particular attention to the means by which organisms deal with their continuously changing environment (i.e., behavior, adaptation, evolution). Two lectures and one laboratory. Prerequisite: Biol 21, 28. Mr. Bean.

329. Herpetology (3)
Biology of amphibians and reptiles. Two lectures and one laboratory or field trip per week. Prerequisite: Biol 21 and consent of department chairman. Open only to students who have not received credit for Biol 429. Mr. Cundall.

331. Nonvascular Plants (3) fall
A comparative study of the ontogenetic and phylogenetic development of algae, fungi and bryophytes. The life cycles and ecological importance of representative organisms are examined. Two lectures and one laboratory. Prerequisite: Biol 21. Ms. Bradt or Mr. Pritchard.

332. Evolution of Vascular Plants (3) spring
A comparative study of the ontogenetic and phylogenetic development of vascular plants. The life cycles, ecological importance and cellular morphology of the higher plants are examined. Emphasis on the plants of Pennsylvania. Two lectures and one laboratory. Prerequisite: Biol 21. Ms. Bradt or Mr. Pritchard.

333. Symbiosis (3) fall
Consideration of factors governing symbiotic relationships, including phoresis, commen-

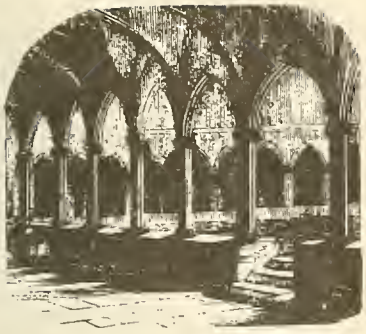

Fig. 626.—CLOISTER OF ARLES, (France.)

salism, parasitism, and mutualism. Lectures and demonstrations emphasizing the theoretical and applied aspects of morphological and physiological adaptation, nutrient assimilation and metabolism, development, host reactions, and the dynamics of host-symbiont interactions are presented. Laboratory experiments designed to acquaint the student with techniques, evaluation of data, and to demonstrate principles are carried out. Prerequisite: Biol 21. Two lectures and one laboratory. Mr. Cheng.

341. Biology of Marine Animals (6) summer
Emphasis on comparative morphology and physiology of marine animals. Field trips for ecological observation and collection as well as anatomical study and physiological experimentation. Prerequisite: consent of instructor and two semesters of biology. (Offered only at The Wetlands Institute.)

353. Virology (3) spring
A lecture course on bacterial and animal viruses including taxonomy, physical and chemical properties, and the biochemical transformations of infected cells. Prerequisite: a course in microbiology or biochemistry. Mr. Malsberger.

361. Sanitary Microbiology (3) spring
Laboratory, field work, and reports on the microbiology of water supplies, waste disposal, and food processing. Two lectures and one laboratory. Prerequisite: one semester of microbiology. Mr. Malsberger.

371. (Chem 371) Elements of Biochemistry I (3) fall
A general study of carbohydrates, proteins, lipids, nucleic acids, and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Prerequisite: one year of organic chemistry. Messrs. Merkel or Schaffer.

372. (Chem 372) Elements of Biochemistry II (3) spring
Dynamic aspects of biochemistry: enzyme reactions including energetics, kinetics, and mechanisms; metabolism of carbohydrates, lipids, proteins, and nucleic acids; photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisite: Chem 371. Messrs. Merkel or Schaffer.

Mini courses at The Wetlands Institute

The following courses, Biol 381 through 386, are one credit mini courses offered only at The Wetlands Institute. Approval of the department chairman is required for all of the courses.

381. Phytoplankton of Estuaries (1)
Survey of the phytoplankton found in New Jersey salt marsh waters. Laboratory work in collecting and identifying organisms, and lectures on the morphology, biochemistry, and physiology of the organisms.

382. Plant Succession in Salt Marshes (1)
Survey of the large plants found in salt marshes and in other marine environments. Field work collecting and identifying the plants; lectures on their biochemistry, physiology, and morphology.

383. Marine Invertebrate Zoology (1)
The dominant taxa of the marine environment: the wetlands fauna, including taxonomy, life history, adaptations, and interrelationships of these organisms. Consideration of the environmental parameters determining the distribution and abundance of marine fauna.

384. Estuarine Zooplankton (1)
Study of temporary and permanent members of the animal plankton of shallow water. Sampling techniques, life histories, and morphology of major forms. Lectures, laboratories, and field trips.

385. Marine Habitats (1)
Ecological field course in the planktonic, benthic, marsh, and sand beach habitat of the South Jersey coast. Emphasis on the major biotic associations in each area and their relationship to physical and chemical influences in the environment. Competition and predation in each habitat.

386. Marine Fish Taxonomy (1)
Lectures in anatomy and physiology of marine fishes. Laboratory will emphasize collecting procedures and identification of specimens.

For graduates

The biology department accepts a limited number of students who are interested in graduate study towards the doctor of philosophy degree. Candidates for the master of science degree are also accepted but emphasis is on the former degree. Currently the department averages about twenty full-time graduate students in residence each year.

The training program initially emphasizes breadth in biology followed by concentration in a special field of interest. Because of the small size of the department staff and the restricted number of graduate students, staff and students work together very closely, especially during the years of student specialization.

The first two or two and one-half years are devoted primarily to course work but some of these are special research and readings courses that may serve as starting points for thesis research. Staff members normally direct student research programs only in the areas encompassed by their own research interests. These are: comparative physiology of nerve and muscle, virology, biological oceanography, behavioral genetics, histochemistry, aquatic biology, biological aspects of water pollution, population ecology, and biology of nucleic acids. Interdisciplinary programs in biological aspects of marine sciences may also be arranged in cooperation with the Center for Marine and Environmental Studies.

Special department requirements for the M.S. degree include one year of graduate biochemistry, one semester of graduate statistics and at least one semester of research, as well as passing an M.S. qualifying examination. Requirements for the Ph.D. degree are determined by the student's special committee and are tailored to fit special needs and interests, but also include passing a special examination as well as a defense of the Ph.D. thesis.

The prerequisite for graduate work in biology is undergraduate training in biology, chemistry, physics and mathematics approximately equivalent to that taken by biology majors at Lehigh University. Minor deficiencies in these areas may be completed during the first year of graduate study, usually, however, without graduate credit. Candidates for admission to

graduate study in biology should take the Graduate Record Examination Advanced Test in biology as well as the GRE Verbal and Mathematical Aptitude tests. Failure to include results of these examinations with application for admission can seriously delay or prevent action on the application.

Current projects in environmental and organismic biology include: cichlid ethology and visual physiology; salt marsh energetics and benthic macrofauna; marine commensalisms and behavioral bioassay; heavy metal cycling in aquatic ecosystems; terrestrial vegetation ecology; population responses to water quality; ecological effects of pesticides; comparative functional morphology of the head in snakes and lizards; feeding behavior in snakes; snake systematics; zooplankton ecology; analysis of salt marsh food webs; evolution and ecology of reproductive patterns in invertebrates; ecology of host-parasite interactions; thermal pollution; and molluscan systematics and evolution.

Current projects in molecular and cell biology include: the behavior of microorganisms and its regulation; physical characterizations of mitochondrial DNA; physical and chemical characterizations of prokaryotic ribosomal RNAs; viral diseases of fishes; developmental plant biology; cytochemistry; and estuarine phytoplankton.

An interdisciplinary Ph.D. program in molecular biology is offered by a committee of molecular biologists with members from the departments of biology, chemistry and physics. For details of the program consult the section on interdisciplinary graduate programs.

Fig. 166.—THE ROYAL EAGLE, (*A. regalis.*)

Graduate courses

402. Comparative Animal Physiology (3)
Lectures and seminars on selected areas in the comparative physiology of animals. Introduction to the current literature of subjects studied. These include mechanisms of osmotic control, temperature effects, nerve and muscle physiology and others. Prerequisite: Biol 320 or 322. Mr. Barber.

405. Special Topics in Biology (1-3)
Research, conferences, and reports on selected topics not covered in the general graduate offerings. May be taken more than once for credit.

406. Biological Seminar (1)
An advanced seminar in current developments including departmental research. Required for candidates for graduate degrees. May be taken more than once for credit.

407. Biological Research (3)
Investigations in any phase of the biological sciences according to the student's preparation and interests.

408. Biological Research (3)
Continuation of Biol 407.

409. Advanced Morphology (3)
A laboratory course in special phases of morphology, such as comparative osteology, comparative morphology, or embryology of the vertebrates, etc., to meet the individual interest of the student. Mr. Cundall.

414. Advanced Ecology (3)
Seminars, conferences, and directed field work with emphasis on theoretical models and their application to real biological systems. May be taken more than once for credit. Prerequisite: consent of department chairman.

415. Cytochemistry (3)
A study of morphological and biochemical events during cell growth and differentiation including lectures, labs, and student reports on current literature. Special emphasis is placed on developmental patterns and laboratory procedures of the cytochemist. Prerequisite: consent of department chairman. Mr. Pritchard.

416. Immunology (3)
Consideration of antigen-antibody systems from theoretical and practical aspects. Lectures and reports on the structure and origins of antigens and antibodies and the mechanisms of agglutination, precipitation, complement fixation, anaphylaxis, etc. Laboratory work on preparation, standardization, and assay of antigens and antibodies. Prerequisite: Biol 353, or Chem 371. Mr. Malsberger.

417. Marine Ecology (3)
Advanced study of the physical and chemical influences in the marine environment on organisms and their interrelations. Ecological theory pertaining to population dynamics and energy flow. Prerequisite: consent of department chairman. Mr. Herman.

418. Biological Oceanography (3)
Surveys of marine plant and animal plankton, nekton and benthos. Composition of various groups, productivity, interrationships of plants and animals and the role of microorganisms in the sea. Prerequisite: consent of department chairman. Mr. Herman.

420. Cellular Mechanisms (3)
Discussions focused on the molecular mechanisms underlying the biology of cellular and microbial systems. Specific topics emphasizing the interests of the participants, but might include: microbial behavior; the evolution and genetics of subcellular specialization; active transport; nucleic acid biochemistry; chromosome replication; cell surface specificities; the functioning of organelles; intracellular and intercellular coordination; viral specificity and reproduction. Mr. Bean.

421. Morphogenesis of the Lower Invertebrates (3)
The structural and chemical aspects of normal and teratological development among the acoelomate and pseudocoelomate phyla are considered from the standpoint of cell and tissue differentiation, comparative morphological and physiological functions, exogenous stimulatory factors, and metabolic requirements. Mr. Cheng.

423. The Biology of Transplantation (3)
The mechanisms, both cellular and humoral, responsible for the recognition of 'self' from 'nonself' in the animal kingdom and the reactive processes resulting from such are explored from the viewpoint of immunity, nutritional uptake, and ontogenetic factors. Mr. Cheng.

425. Biological Electron Microscopy (3)
Uses of the transmission and scanning electron microscopes in biology. Lectures and laboratory work in the preparation of biological specimens for study with both kinds of electron microscopes and some independent work at the transmission electron microscope. Study of current information on cell ultrastructure. Mr. Barber or Mr. Krawiec.

429. Herpetology (3)
Contains subject matter of Biol 329 plus additional work. Open only to students who have not received credit for Biol 329. Mr. Cundall.

433. Growth and Development in Plants (3)
A comparative study of embryo and cellular development in the plant kingdom including the algae, bryophytes and tracheophytes. Emphasis is placed on morphology, physiology and the role of macromolecular substances during growth and differentiation. Literature search, experimental work and oral reports. Two lectures and one laboratory. Mr. Pritchard.

435. Ethology (3)
Advanced topics in behavior, including stereotyped action patterns, receptor and central nervous information processing, and techniques of behavioral investigation. Seminar format. Prerequisite: consent of department chairman. Mr. Bell.

441. Marine Botany (3)
A study of the morphological, physiological, biochemical and ecological features of those plants found primarily in the salt water environment. Emphasis is placed on the evolutionary and ecological significance of the phytoplankton, benthic algae and rooted aquatic plant divisions associated in and near the oceans. The economic importance of these plants is considered. Laboratory work, field work and library searches and reports. Messrs. Pritchard and Herman.

442. Marine Zooplankton (3)
A comprehensive study of neritic and oceanic plankton. Studies on the life history, morphology and distribution of both holoplanktonic and meroplanktonic animals. Prerequisite: consent of department chairman. Mr. Herman.

443. Ichthyology (3)
Lectures and laboratory on the anatomy, physiology, behavior and taxonomy of marine and freshwater fishes. Mr. Malsberger.

444. (Geol 444) Multivariate Analysis (3)
The strategy of the application of multivariate analysis techniques to problems in geology and biology. Analysis of large data matrices by factor analysis, cluster analysis, discriminant function analysis, ordination and related techniques. Examples from both geology and biology. Prerequisites: Geol 10 and Geol 321 or approved equivalents. Mr. Parks and Mr. Carson.

445. Nucleic Acids and Nucleic Acid Complexes (3)
Structure of DNA, replicative intermediates and chromosomes; messenger RNA, transfer RNA, ribosomal RNA, and ribosomes. Readings, lectures, and recitations. Prerequisite: consent of department chairman. Mr. Krawiec.

447. (Chem 447) Experimental Molecular Biology (3)
A survey of current research in molecular biology.

480. (Geol 480) Marine Science Seminar (1)
An advanced interdisciplinary seminar on various problems of marine sciences, with visiting speakers and student presentations. May be substituted for Biol 406.

CHEMICAL ENGINEERING

Professors. Leonard A. Wenzel, Ph.D., chairman; Curtis W. Clump, Ph.D.; William L. Luyben, Ph.D.; Gary W. Poehlein, Ph.D.; William E. Schiesser, Ph.D., McCann Professor; Fred P. Stein, Ph.D.

Associate professors. Marvin Charles, Ph.D.; Anthony J. McHugh, Ph.D.; Laslo Nyiri, Ph.D; Leslie H. Sperling, Ph.D.

Assistant professors. Mohamed S. El-Aasser, Ph.D.; Donald D. Joye, Ph.D.

Lecturers. Jacob M. Geist, Ph.D.; Abraham Lapin, Ph.D.; Clyde McKinley, Ph.D.

Research associates. Herman George, M.S.; James Palmer, Ph.D.; George H. Pauli, Ph.D.

Course of study

Preparation for chemical engineering requires a sound background in the fundamental sciences of physics, chemistry, and mathematics plus a general background training in the application of these fundamentals to carrying forward into industrial production the new products and processes discovered in the laboratory.

This latter training is directly called chemical engineering. In accord with this philosophy, the student is not trained for any specific industry, but the education is sufficiently broad that a graduate is competent to enter any of the chemical and allied industries.

The objective of the curriculum is to develop in the student an understanding of the scientific fundamentals, an ability with mathematical tools, and the habits of precise analysis of process engineering problems that will allow him or her to function effectively in this broad field, and to grow into positions of responsibility. Of course these technical abilities must be coupled with an understanding of the economic, sociological, and cultural environment within which the engineer operates. The curriculum includes a relatively large commitment to education in these latter areas.

The program also is designed to prepare a student for graduate study in chemical engineering or in peripheral fields. Further study at the graduate level leading to advanced degrees is highly desirable in preparation for careers in the more highly technical aspects of manufacturing. The increasing complexity of modern manufacturing methods requires superior training for men and women working in the research, development, and the design fields or for teaching.

Career opportunities

Chemical engineers play important roles in all activities bearing on the chemical process industry. These include the functions of research, development, design, plant construction, plant operation and management, corporate planning, technical sales, and market analysis.

The industries that produce chemical and/or certain physical changes in fluids including petroleum and petrochemicals, rubbers and polymers, pharmaceuticals, metals, industrial and fine chemicals, foods, and industrial gases have found chemical engineers to be vital to their success. Chemical engineers are also important participants in pollution abatement, energy resources, and national defense programs.

Physical facilities

The department is located in Whitaker Laboratory. In this building some 40,000 square feet of space is available for the research, teaching, and office needs of the department.

The building is air conditioned, and includes specially designed facilities for analog computation, calibration standards, a minicomputer for process dynamics study, specially protected rooms for reaction kinetics and thermodynamics research, and for high pressure research, special equipment for biochemical engineering, and a wide range of general laboratory equipment for undergraduate study of the behavior of typical chemical processing units.

More complete descriptions of research equipment can be found in the following section on graduate programs in chemical engineering.

Special programs and opportunities

The department currently operates a cooperative program that is optional for specially selected students who have completed their sophomore year. This program affords early exposure to industry and an opportunity to integrate academic background with significant periods of engineering practice. Students in this program are able to earn most of their college expenses.

Opportunities for undergraduate involvement in research projects, special design projects, and programs of independent study are many, but are usually arranged specifically between a student and a professor. The high degree of curricular flexibility encourages this, and also allows the student to emphasize an area of special interest in the selection of electives. In some cases this may lead to a minor in addition to the chemical engineering major.

Major requirements

freshman year: see Recommended Freshman Year, page 40.

sophomore year, first semester (18 credit hours)

Math 23	Analytical, Geometry & Calculus III (4)
ChE 41	Cascade Processing Concepts (3)
Chem 31	Equilibria (4)
Eco 1	Economics (4)
	elective * (3)

sophomore year, second semester (15-18 credits)

Math 205	Linear Methods (3)
ChE 52	Fundamentals of Transport Phenomena (4)
Chem 187	Thermodynamics (3)
Physics 21, 22	Introductory Physics II & Lab (5)
	electives * (0-3)

junior year, first semester (16 credit hours)

Chem 51, 53	Organic Chemistry & Lab (4)
Chem 191	Physical Chemistry (3)
ChE 167	Unit Operations (3)
	General Studies requirement (3)
	elective * (3)

junior year, second semester (15-18 credits)

Chem 192	Physical Chem Lab (1)
ChE 286	Modeling, Simulation & Control (3)
ChE 210	Thermodynamics (4)
ChE 169	Unit Operations Lab I (1)
	General Studies requirement (3)
	electives * (3-6)

junior year, summer

ChE 100	Industrial Employment

senior year, first semester (16 credit hours)

ChE 302	Chemical Engineering Kinetics (3)
ChE 174	Chem Plant Design (3)
ChE 170	Unit Operations Lab II (1)
	General Studies requirement (3)
	electives * (6)

senior year, second semester (15-18 credits)

	General Studies requirement (3)
	electives * (12-15)

The twenty-seven hours of electives included in the minimum degree program must be taken from the following distribution:
Chemistry: six hours
Engineering sciences: (including Mech 1 or Mech 103):
twelve hours
Free electives: nine hours

*Please refer to description of normal program.

Undergraduate courses

41. Cascade Processing Concepts (3) fall
Concepts of equilibrium in gas, liquid, and solid systems. Engineering of sequential and cascade processing methods from technical and economic considerations. Computer modeling of leaching, extraction, and distillation processes. Prerequisite: Engr 1 or equivalent in programming.

52. Introduction to Transport Phenomena (4) spring
The principles of transport of energy, momentum, and mass and the analogies between them. Transport coefficients and their evaluation. Applications in variable-property fields within a phase. Three recitations and one lab per week.

60. Unit Operations Survey (3) fall
The theory of heat, mass, and momentum transport. Laminar and turbulent flow of real fluids. Heat transfer by conduction, convection, and radiation. Application to a wide range of operations in the chemical and metallurgical process industries.

100. Summer Employment
During the summer (preferably following the junior year) candidates for the degree of bachelor of science in chemical engineering are required to obtain industrial experience through employment for at least eight weeks in a plant or laboratory or engineering office and submit a report thereon.

167. Unit Operations (3) fall
Applications of transport phenomena and conservation principles as applied to chemical processing equipment. Prerequisite: ChE 52.

169. Unit Operations Laboratory I (1)
Laboratory experience in unit operations. Prerequisite: ChE 167 previously or concurrently.

170. Unit Operations Laboratory II (1)
Laboratory experience with steady state and dynamic process operations. Prerequisite: ChE 286 previously or concurrently.

174. Chemical Plant Design (3) fall
A study of the technical and economic aspects of the design, location, and operation of chemical plants. Prerequisite: ChE 166 or ChE 286.

179. Professional Development (1) fall
Elements of professional growth, registration, ethics, and the responsibilities of engineers both as employees and as independent practitioners. Proprietary information and its handling. Patents and their importance. Discussions with the staff and with visiting lecturers. A few plant trips. Prerequisite: junior standing.

185. Undergraduate Research I (3)
Independent study of a problem involving laboratory investigation, design or theoretical studies under the guidance of a senior faculty member.

186. Undergraduate Research II (3)
A continuation of the project begun under ChE 185. Prerequisites: ChE 185 and consent of the department chairman.

For advanced undergraduates and graduates

210. Chemical Engineering Thermodynamics (4) spring
Energy relations and their application to chemical engineering. Consideration of flow and nonflow processes. Evaluation of the effects of temperature and pressure on the thermodynamic properties of fluids. Heat effects accompanying phase changes and chemical reactions. Determination of chemical and physical equilibrium. Prerequisite: Chem 187 or equivalent.

286. Modeling, Simulation, and Control (3) spring
Review of physical laws that are the basis for mathematical models of physical systems. Mathematical modeling of important chemical engineering systems. Digital and analog computer simulation techniques for solution of ordinary differential equations describing chemical processes. Practical aspects of process control system design and operation. Exposure to control equipment: sensors, transmitters, controllers and control valves. Prerequisite: Math 205.

300. Apprentice Teaching in ChE (1-3)

301. Process Design (3) spring
Study of the strategy of chemical process design with emphasis on optimum order of steps, flow diagrams, energy balances, recycle ratios and their effect on the economics of the operation. Survey of methods for ordering equations. Discussion of process optimization for nonlinear systems. Effects of uncertainty in process design.

302. Chemical Engineering Kinetics (3) fall
The application of chemical kinetics to the design and operation of reactors. Interrelations of kinetics, thermodynamics and unit operations. Prerequisites: ChE 167 or 286, ChE 210 or equivalent, previously or concurrently.

312. (ChE 312, Met 312) Fundamentals of Corrosion (3) fall
Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization, and passivity. Nonelectrochemical corrosion including mechanisms, theories, and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisite: Met 210, Chem 187, or equivalent. Messrs. Leidheiser or Smyth.

320. Waste Water Control (3) fall
The physical processes of importance in the design of industrial waste water treatment facilities. Topics will include sedimentation and filtration processes as well as advanced methods such as adsorption, ion exchange, osmosis, foaming, freezing, and hydrate formation.

321. Fundamentals of Air Pollution (3) spring
Introduction to the problems of air pollution including such topics as: sources and dispersion of pollutants; sampling and analysis; technology of economics and control processes; legislation and standards. Prerequisite: senior standing in the College of Engineering and Physical Sciences.

331. Distillation (3)
Design and operating strategies and techniques. Computer solutions for simple and complex, multicomponent distillation columns. Shortcut design methods. Tray hydraulics and constraints. Petroleum fractionators and azeotropic and extractive distillation.

340. Biochemical Engineering (3)
An introduction to various aspects of the utilization of industrially important bacteria, fungi, and yeasts. Biochemical activities and significant metabolic products of these microorganisms are discussed as are aspects of fermentor design. Consideration is given to product purification and end use. Two recitations and one laboratory period per week. Prerequisite: consent of chairman.

350. Special Topics (3)
A study of areas in chemical engineering not covered in courses presently listed in the catalog. May be repeated for credit if different material is presented.

360. (ME 360) Nuclear Reactor Engineering (3) fall-spring
A consideration of the engineering problems in nuclear reactor design and operation. Topics include reactor fuels and materials, thermal aspects, instrumentation and control problems, radiation protection and shielding, fuel processing, and reactor design. Prerequisite: senior standing in engineering or physical science. Messrs. J. Chen, Clump and Kosky.

380. Design Projects (1-6)
Design project work as a member of a team, preferably including students from differing disciplines. The project attacks a problem which, when possible, involves one of the local communities or industries. Specific projects are normally guided by faculty from several departments with consultants from off the campus. The course is offered both semesters and may be repeated for credit.

386. Process Control (3) fall
Laplace transformation and transfer functions, frequency response, feedback and feedforward control. Openloop and closedloop stability analysis using root locus and Nyquist techniques, design of feedback controllers with time and frequency domain specifications. Experimental process identification, introduction to sampled-data control theory. Prerequisite: ChE 286 or equivalent.

390. (Chem 390) Polymer Synthesis and Characterization (1-3)
Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties. Prerequisite: Chem 51, 187, 191.

392. (Chem 392) Polymer Science (3) spring
Introduction to concepts of polymer science. Kinetics and mechanism of polymerization, synthesis and processing of polymers, characterization. Relationship of molecular conformation, structure and morphology to physical and mechanical properties. Prerequisite: Chem 187 or equivalent.

393. (Chem 393, Met 343) Physical Polymer Science (3) fall
Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline, and paracrystalline states (including viscoelastic and relaxation behavior) for single and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology, and behavior. Prerequisite: one year of physical chemistry.

394. (Chem 394) Organic Polymer Science (3) spring
Organic chemistry of synthetic high polymers. Functionality and reactivity of monomers and polymers. Theory of stepgrowth and chaingrowth polymerization in homogeneous and heterogeneous media. Polymerization by addition, elimination, substitution and coupling reactions. Ionic fee-radical and coordinate catalysis. Prerequisites: one year of physical chemistry and one year of organic chemistry.

Graduate programs

The department of chemical engineering offers graduate programs leading to both the master of science and doctor of philosophy degrees. The programs are all custom-tailored for individual student needs and professional goals. This is made possible by a diversity of faculty interests which is broadened and reinforced by cooperation between the department and several research centers on campus.

A free flow of personnel and ideas between the centers and academic departments ensures that the student will have the widest choice of research activities. The student is also exposed to a wide range of ideas and information through courses, seminars, etc., to which both faculty and center personnel contribute. In addition, strong relationships with industry are maintained by the department and the research centers, some of which operate industrially sponsored liaison programs whereby fundamental nonproprietary research is performed in areas of specific interest to participating sponsors.

Some of the centers currently operating are: Center for Health Sciences, Center for Information Science, Center for Marine and Environmental Studies, Center for Surface and Coatings Research, Center for the Application of Mathematics; Materials Research Center, and Center for Social Research.

While the department has interacted with almost all of these centers, it has had unusually strong and continuing liaisons with the Materials Research Center and the Center for Surface and Coatings Research.

In addition to interacting with the centers, the department originates and encourages programs which range from those which are classically chemical engineering to those which are distinctly interdisciplinary. The department offers active and growing programs in: emulsion polymerization and latex technology; process control; process improvement studies; rheology; computer applications; environmental engineering; thermodynamics; kinetics and catalysis; enzyme technology; and biochemical engineering.

Wherever possible, attempts are made to gain the cooperation and participation of other academic departments and research centers in building these programs.

Career opportunities

Master of science and doctor of philosophy graduates in the chemical engineering area are sought by industry for activities in the more technical aspects of their operations, especially design, process and product development, and research. Many of these graduates also find opportunities in research or project work in government agencies and in university teaching and research.

Physical facilities

The department is well equipped for research in polymer science and engineering, catalysis and reaction kinetics, thermodynamic property studies, fluid dynamics, heat and mass transfer, process dynamics and control, and enzyme engineering and biochemical engineering.

Major facilities include a PDP 11/40 real time computer, differential scanning calorimeter, Phillips transmission electron microscope plus scanning attachment, RCA transmission electron microscope, ETEC scanning electron microscope, gel permeation chromatograph, intrinsic viscosity measurement, Weissenberg rheogoniometer, continuous particle electrophoresis unit, surface titration unit, preparative and analytical ultracentrifuges, liquid chromatography unit for colloid particle

Fig. 1988. — PREPARATION OF OLEFIANT GAS.

size analysis, polymerization reactor systems, vapor-liquid equilibria cell, PVT unit, Joule-Thomson coefficient unit, fluid-bed enzyme catalysis pilot plant, instrumented fermentation cells, hot wire anemometer, and high-pressure catalytic reaction unit.

Special programs

M.S. design option

For those interested in design, the department offers the M.S. design option. In this program, the student works on a design project proposed by the process design group of a cooperating industry. Direction of the design project is shared by the cooperating industry and a member of the faculty. Students desiring to enroll in this program should indicate that fact at the time they apply for admission.

Chemical metallurgy program

The chemical metallurgy program is jointly administered by the departments of chemical engineering and metallurgical engineering and should be particularly appealing to students interested in process metallurgy.

The student's program is arranged to supplement the B.S. program so that he or she understands the technology of the extractive metallurgy industry and acquires the tools needed to work effectively in it. The master of science thesis is chosen from problems relevant to the metals processing industry.

Polymer science and engineering

The polymers activity at Lehigh includes work done in the Materials Research Center, the Center for Surface and Coatings Research, the Center for the Application of Mathematics, the chemistry department, and the department of chemical engineering.

About a dozen faculty members from these organizations or areas have major interests in polymers and cooperate on a wide range of research projects. For students with deep interest in the area, degree programs are available leading to the master of science and Ph.D. degrees in polymer science and engineering.

Research activities on which chemical engineering students and faculty are involved include a major study of impregnation of bridge decks with polymers to increase surface life; studies of the mechanism of continuous emulsion polymerization; work on polymer blends, especially interpenetrating polymer networks, and the application of these materials to sound-deadening; rheology of viscoelastic materials; crystallization behavior from polymer melts and solutions; polymer film characteristics and the tailoring of these properties for selective transfer rates; latex film drying rates; coatings and the hiding capabilities of micropores; and the preparation of polymeric materials from agricultural raw materials.

Master of engineering degree

Students may earn the master of engineering degree in chemical engineering upon completion of a course of study and an engineering project meeting all the requirements of the master of science degree. The M.E. student, however, elects courses closer to engineering practice, and carries out a project of more practical engineering flavor than that of the M.S. candidate. In some cases the project of the M.E. student will be done in close collaboration with local industry.

Fig. 1795. — SOLDIER'S NATIONAL ASYLUM AT MILWAUKEE.

Major requirements

The requirements for the master of science degree are listed in the section on The Graduate School. All candidates for the M.S. degree are required to complete an M.S. research report for which three to six hours of graduate credit is earned. Course selection is done individually for each student, although ChE 400 and ChE 415 are considered as core courses.

The requirements for the Ph.D. degree also are listed in the section on the Graduate School. In addition to an approved course and thesis program, the Ph.D. student is expected to pass a qualification examination given within the first year of doctoral-level study, to demonstrate proficiency in one modern foreign language, and to pass a general examination based on two research proposals or independent problems presented by the student.

Course descriptions

400. Chemical Engineering Thermodynamics I (3) fall
Applications of thermodynamics in chemical engineering. Topics include energy and entropy, heat effects accompanying solution, flow of compressible fluids, refrigeration including solution cycles, vaporization and condensation processes, and chemical equilibria. Prerequisite: an introductory course in thermodynamics. Mr. Stein.

401. Chemical Engineering Thermodynamics II (3) spring
A detailed study of the uses of thermodynamics in predicting phase equilibria in solid, liquid, and gaseous systems. Fugacites of gas mixtures, liquid mixtures, and solids. Solution theories; uses of equations of state: high-pressure equilibria. Mr. Stein.

410. Chemical Engineering Kinetics (3)
The application of chemical kinetics to the engineering design and operation of reactors. Non-isothermal and adiabatic reactions. Homogeneous and heterogeneous catalysis. Residence time distribution in reactors. Prerequisite: ChE 302.

413. Heterogeneous Catalysis (3)
Surface area, pore structure and pore-size distribution of catalysts. Influence of pore-diffusion on catalytic reactions and the design of catalytic reactors. Chemical adsorption and physical adsorption. Chemistry, energetics and kinetics of adsorption, desorption, and surface reaction. Electronic structure and catalysis; atomic orbital and bondstructure models. Mechanisms of catalytic reactions of industrial importance. Selection and classification of catalysts.

415. Transport Processes (3)
A combined study of the fundamentals of momentum transport, energy transport and mass transport and the analogies between them. Evaluation of transport coefficients for single and multicomponent systems. Analysis of transport phenomena through the equations of continuity, motion, and energy.

421. Heat Transfer (3)
Analysis of steady and unsteady state transfer. Convection, conduction, and radiation. Vaporization and condensation. Heat transfer in high velocity flow and in rarified gases. Applications.

428. Rheology (3)
An intensive study of momentum transfer in elastic viscous liquids. Rheological behavior of solution and bulk phase polymers with emphasis on the effect of molecular weight, molecular weight distribution and branching. Derivation of constitutive equations based on both molecular theories and continuum mechanics principles. Application of the momentum equation and selected constitutive equations to geometrics associated with viscometric flows.

430. Mass Transfer (3)
Theory and developments of the basic diffusion and mass transfer equations and transfer coefficients including simultaneous heat and mass transfer, chemical reaction, and dispersion effects. Applications to various industrially important operations including continuous contact mass transfer, absorption, humidification, etc. Brief coverage of equilibrium stage operations as applied to absorption and to binary and multicomponent distillation.

440. Process Design (3)
Synthesis of flow sheets for various processes, investigation of contributions to over-all economy of various alternatives. Evaluation of profitability of alternatives.

441. Advanced Process Control (3)
Sampled-data control theory with applications in digital computer control systems. Nonlinear methods of dynamic analysis. Optimal control via calculus of variations and the maximum principle. Mr. Luyben.

450. Special Topics (3-12)
An intensive study of some field of chemical engineering not covered in the more general courses. Credit above three hours is granted only when different material is covered.

451. Problems in Research (1)
Study and discussion of optimal planning of experiments and analysis of experimental data. Discussion of more common and more difficult techniques in the execution of chemical engineering research.

455. Seminar (1-3)
Critical discussion of recent advances in chemical engineering. Credit above one hour is granted only when different material is covered.

460. Chemical Engineering Project (1-6)
An intensive study of one or more areas of chemical engineering, with emphasis on engineering design and applications. A written report is required. May be repeated for credit.

461. Mathematical Methods in Chemical Engineering 1 (3)
Application of ordinary and partial differential equations to the solution of chemical engineering problems with emphasis on chemical reactions and transport processes as they occur in industrial chemical processing. Applications of solution in series, separation of variables, and integral transforms. Prerequisite: Math 322.

464. Numerical Methods in Engineering (3) fall
Applied computer-oriented mathematics including linear difference operators, interpolation polynomials, numerical quadrature based on the Newton Cotes open and closed formulas, matrices and linear algebra with emphasis on the solution of large sparse systems, algorithms for nonlinear algebraic and transcendental systems. Computer solution of problems selected from a number of scientific and engineering disciplines. Mr. Schiesser.

465. Numerical Methods in Engineering (3) spring
A continuation of ChE 464 with emphasis on the numerical integration of ordinary and partial differential equations. Topics include: single step and multistep algorithms for initial value problems in ordinary differential equations, error monitoring and control, stability and the integration of stiff systems, geometric classification of partial differential equations, explicit and implicit finite difference algorithms, convergence, consistency and stability. Mr. Schiesser.

470. Cryogenic Engineering (3)
Liquefaction and separation of gases, physical and chemical principles. Low temperature thermometry. Insulation. Properties of fluids and of structural materials. The behavior of helium. Ultra-low temperature phenomena and theories. Mr. Wenzel.

471. Low Temperature Processes (3)
The problems and design of plants operating in the cryogenic temperature range. Refrigeration demands. Distillation and heat exchange at low temperatures. Analysis of processes for thermodynamic and operating efficiency. Problems of safety, non-steady state behavior and control. Mr. Wenzel.

480. Research (3-4)
Investigation of a problem in chemical engineering.

481. Research (3-4)
Continuation of ChE 480.

482. (Chem 482, Met 482) Engineering Behavior of Polymers (3)
A treatment of the mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture and aging on mechanical behavior. Mr. Robinson.

483. (Chem 483) Emulsion Polymers (3)
Examination of fundamental concepts important in the manufacture, characterization, and application of polymer latexes. Topics to be covered will include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation, and various application problems.

484. (Chem 484) Crystalline Polymers (3)
An in-depth treatment of the morphology and behavior of both polymer single crystals and bulk crystallized systems. Emphasis is placed on the relationship between basic crystal physics, thermal and annealing history, orientation and resulting properties. A detailed discussion of the thermodynamics and kinetics of transition phenomena and a brief treatment of hydrodynamic properties and their relationship to crystallization and processing properties. Prerequisite: ChE 392 or ChE 393 or equivalent. Mr. McHugh.

485. (Chem 485) Polymers Blends and Composites (3)
An intensive study of the synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated concrete, and fiber and particulate reinforced polymers are emphasized. Prerequisite: any introductory course in polymers.

492. (Chem 492) Topics in Polymer Science (3)
Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered. Prerequisite: Chem 392 or equivalent.

CHEMISTRY

Professors. Frederick M. Fowkes, Ph.D., chairman; Albert C. Zettlemoyer, Ph.D., distinguished professor, vice president and provost; Eugene M. Allen, Ph.D.; Thomas C. Cheng, Ph.D., director, Center for Health Sciences; Charles S. Kraihanzel, Ph.D.; Henry Leidheiser, Jr. Ph.D., director, Center for Surface and Coatings Research; Ned D. Heindel, Ph.D., Howard S. Bunn distinguished professor of chemistry and director, Division of Biological Chemistry and Biophysics, Center for Health Sciences; Kamil Klier, Ph.D.; Roland W. Lovejoy, Ph.D.; John A. Manson, Ph.D., director of the Polymer Laboratory, Materials Research Center; Joseph R. Merkel, Ph.D.; William E. Ohnesorge, Ph.D.; Donald M. Smyth, Ph.D., director, Materials Research Center; Robert S. Sprague, Ph.D.; James E. Sturm, Ph.D.; John W. Vanderhoff, Ph.D., associate director, Center for Surface and Coatings Research; Thomas E. Young, Ph.D.

Associate professors. Fortunato J. Micale, Ph.D.; Keith J. Schray, Ph.D.; Gary W. Simmons, Ph.D., assistant to the director, Center for Surface and Coatings Research; Daniel Zeroka, Ph.D.

Assistant professors. Michael C. Hughes, Ph.D.; Robert S. Rodgers, Ph.D.; Stephen W. Schaffer, Ph.D.

Visiting lecturers. John W. LeMaistre, Ph.D.; Heinz G. Pfeiffer, Ph.D.; Eugene W. Rice, Ph.D.; Courtland N. Robinson, Ph.D.

Chemistry is a basic science of such intellectual challenge that most graduates continue study for advanced degrees, yet it is so practical that

200,000 chemists provide the technical backbone of the manufacturing industries.

Students majoring in chemistry receive an education which provides a broad base for further specialization in a wide variety of careers. A degree in chemistry (with biology electives) is the strongest preparation for medical school, and an excellent background for graduate studies in other health-related disciplines (biochemistry, pharmacology, immunology, pathology, etc.). Graduate schools accept chemistry majors into a variety of other programs (physics, materials science, oceanography, environmental studies, mineralogy, etc.).

Within the field of chemistry, graduates are prepared for research (in universities, government laboratories, or industrial laboratories), for teaching (in universities, colleges, or high schools), for industrial positions (in product development, sales, or management) and for government positions (pollution control, Food and Drug Administration, etc.).

Most chemists are employed in manufacturing industries (pharmaceuticals, plastics, fibers, rubber, paper, coatings, electronics, materials, automobiles, aircraft, petroleum, agricultural chemistry, etc.) and in many of these industries chemists rise to top management positions.

The undergraduate curriculum in chemistry contains many of the prerequisites for biology, geology, metallurgy, physics, and chemical engineering so that students can easily transfer with no loss of credits, even in the junior year.

The new undergraduate curriculum leading to a bachelor of science degree in biochemistry is a program of the College of Engineering and Physical Sciences and is based on the standard freshman year and the normal sophomore year of the chemistry curriculum. Concentration in biochemistry courses takes place in the junior and senior years at the expense of some electives and of two courses in the normal chemistry curriculum. Consequently graduates of this program are prepared to go into graduate work in several fields (medicine, biochemistry, chemistry, biophysics, and biology). This curriculum requires 129 semester hour credits, but under special circumstances graduation is permitted with only 121 semester hour credits.

Chemistry students have the opportunity to design their undergraduate curricula for specialization in a variety of fields:

Health-related chemistry (including premedical students)

Suggested biology electives: 21, 22, 35, 320, 353
Suggested chemistry electives: 336, 352, 371, 372, 377, 378
Suggested physics electives: 367, 368
The above electives may be used in place of Math 205 and German.

Materials chemistry (polymer, solid state, surface)

Suggested physics electives: 31, 363
Suggested chemistry electives: 312, 390, 392, 393, 394, 395, 396

Environmental chemistry

Suggested biology electives: 21, 22, 35, 306
Suggested chemical engineering electives: 320, 321
Suggested chemistry electives: 303, 334, 395, 310
The above electives may be used in place of Math 205 and German.

Geochemistry

Suggested geology electives: 333, 334, 336, 352, 372
Suggested chemistry electives: 303, 396
The above electives may be used in place of Math 205 and German.

Chemistry management

Suggested mathematics substitution: 231 for 205 (permits B.S. plus M.B.A. in five years)
Suggested accounting electives: 108, 111
Suggested law elective: 101
Suggested management electives: 201, 302
Suggested chemistry electives: 390, 392, 397
The above electives may be used in place of German.
Suggested economics electives: 129, 206
Suggested marketing elective: 211
Suggested finance elective: 225

Accelerated programs

A three-year bachelor of science degree and a four-year master of science degree in chemistry are available as part of the six-year B.S. and M.D. plan of Lehigh and Hahnemann Medical College. See the section on Health Professions. Eligibility is limited to students entering the university with credit for Chem 21 and 22.

The five-year program

Five-year programs are available for students to receive B.S. or B.A. degrees and the master of science degree in several fields of chemistry (inorganic, organic, analytical, or physical chemistry, polymers, or biochemistry). A five-year program also is available for a B.S. degree in chemistry and a master's degree in business administration (M.B.A.).

B.A. and B.S. degrees in chemistry

Lehigh University offers a bachelor of arts degree in chemistry from the College of Arts and Science and a bachelor of science degree in chemistry from the College of Engineering and Physical Sciences. In most classes, the B.S. candidates outnumber the B.A. candidates in chemistry, but not always. The required courses in science and mathematics are identical for the two programs; these are shown in the recommended sequence of courses for the B.S. degree. The difference in the two programs lies in the distribution of courses in the humanities and social sciences.

German is not required for the B.A. degree. It is a normal requirement for the B.S. degree (but it can be substituted). The B.A. degree requires 120 semester hour credits and the B.S. degree normally requires 129 semester hour credits; a minimum program of 121 semester hour credits is permitted for the B.S. degree under special conditions which are detailed on page 40.

Recommended sequence of courses for the B.S. degree in chemistry

freshman year (see page 40)

sophomore year, first semester (16 credit hours)

Chem 51	Organic Chemistry (3)
Chem 53	Organic Chemistry Lab (1)
Chem 31	Chemical Equilibria (3)
Phys 21	Introductory Physics (4)
Phys 22	Introductory Physics Lab II (1)
Math 23	Analytical Geometry and Calculus III (4)

sophomore year, second semester (15-18 credits)

Chem 52	Organic Chemistry (3)
Chem 54	Organic Chemistry Lab (2)
Chem 187	Physical Chemistry (3)
Math 205	Linear Methods (or approved substitute) (3)
Eco 1	Economics (4)

junior year, first semester (15 credit hours)

Chem 188	Physical Chemistry Lab (2)
Chem 191	Physical Chemistry (3)
Chem 234	Analytical Chemistry Lab (1)
Chem 332	Analytical Chemistry (3)
Chem 358	Advanced Organic Chemistry (3)
Ger 1	Elementary German (or approved substitutes) (3)

junior year, second semester (16 credit hours)

Chem 307	Inorganic Chemistry (3)
Chem 383	Advanced Chemical Experimentation (4)
German 2	Elementary German (or approved substitute) (3)
	General Studies requirement (6)

senior year, first semester (14-18 credit hours)

Chem 381	Radiation and Structure (3)
Chem	elective (2-3)
	electives (9-12)

senior year, second semester (14-15 credit hours)

Chem	elective (2-3)
	electives (12)

Chemistry electives are any two courses (200 to 400 level) in science or engineering; at least one must include a laboratory. Note: If German courses are substituted, General Studies courses must be added.

Recommended sequence of courses for the B.S. degree in biochemistry

sophomore year, first semester (same as chemistry)

sophomore year, second semester (18 credits)

Chem 52	Organic Chemistry (3)
Chem 54	Organic Chemistry Lab (2)
Chem 187	Physical Chemistry (3)
Math 205	Linear Methods (or approved substitutes) (3)
Eco 1	Economics (4)
Bio 21	Principles of Biology (3)

junior year, first semester (16 credit hours)

Chem 191	Physical Chemistry (3)
Chem 234	Analytical Chemistry Lab (1)
Chem 332	Analytical Chemistry (3)
Chem 371	Biochemistry I (3)
Chem 377	Biochemistry Lab (3)
German 1	Elementary German (or approved substitute) (3)

junior year, second semester (16 credit hours)

Chem 307	Inorganic Chemistry (3)
Chem 372	Biochemistry II (3)
Chem 383	Advanced Chemical Experimentation (4)
German 2	Elementary German (or approved substitute) (3)
Biol	elective (3) or
Biophys	elective (3)

senior year, first semester (15-16 credit hours)

Chem 358	Advanced Organic Chemistry (3)
Biol	elective (3-4)
Biochem	elective (3) or
Biophys	elective (3)
	General Studies requirement (3)
	electives (3)

senior year, second semester (12-15 credits)

Biophys	elective (3)
Biochem	Elective (3) or
Biophys	Electives (3)
	General Studies requirement (3)
	electives (3-6)

Biology electives include Biol 21, 28, 35, 320, 353; nine credits required. Biophysics electives include Phys 367, 368 (Chem 303 also approved); three credits required.

Biochemistry electives include Chem 378, 350, 375; two credits required. Note: If German courses are subsitituted, General Studies courses must be added.

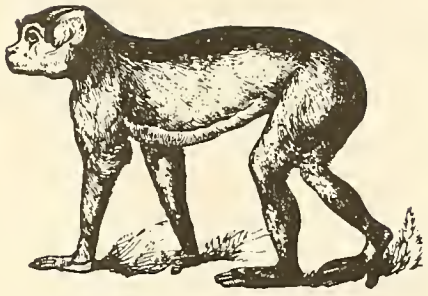

Fig. 1684. — MAGOT, OR BARBARY APE.

Undergraduate courses

21. Introductory Chemical Principles (4) fall-spring
An introduction to certain important principles of chemistry. Topics include atomic structure and bonding, stoichiometry, states of matter, and introductions to kinetics, chemical equilibrium, acid-base theories, oxidation-reduction reactions, and galvanic cells. Math 21, 31, or 41 previously or concurrently. Two lectures, two recitations. Mr. Sprague or Mr. Kraihanzel.

22. Chemical Principles Lab (1) fall-spring
A laboratory course to be taken concurrently with Chem 21. An introduction to chemical laboratory techniques with emphasis on quantitative measurements. One three-hour laboratory period per week. Mr. Sprague or Mr. Kraihanzel.

23. Environmental Aspects of Analytical Chemistry (3) spring
The fundamentals, theory, and practice of the analytical chemical methods used to examine air, water, and soil samples for the trace impurities. Selected topics in the areas of classical and instrumental methods. Prerequisite: Chem 21. Mr. Hughes.

31. Chemical Equilibria in Aqueous Systems (3) fall-spring
Mass law calculations involving acid-base, solubility, complexation and oxidation-reduction equilibria in aqueous solution. Introduction to the thermodynamics of chemical systems. Descriptive chemistry of familiar representative elements and certain of the transition metal elements with emphasis on behavior in aqueous systems. The laboratory work emphasizes qualitative and quantitative analysis. Prerequisites: Chem 21, Math 21, Phys 11. Two lectures, one three-hour recitation-lab period per week. Mr. Sprague.

39. Analytical Chemistry (3) spring
The fundamentals, theory, and practice of analytical chemistry for all students except chemistry majors. Selected topics in the areas of classical and instrumental analysis. Fundamental techniques are presented in the laboratory. Two lectures, one laboratory period. Prerequisite: Chem 21. Mr. Hughes, Mr. Ohnesorge or Mr. Rodgers.

51. Organic Chemistry (3) fall
Systematic survey of the typical compounds of carbon, their classification, and general relations; study of synthetic reactions. Prerequisite: Chem 21. Mr. Heindel, Mr. Schray or Mr. Young.

52. Organic Chemistry (3) spring
Continuation of Chem 51. Prerequisite: Chem 51.

53. Organic Chemistry Laboratory (1) fall
Preparation of pure organic compounds. Prerequisite: Chem 21. Mr. Heindel, Mr. Schray or Mr. Young.

54. Organic Chemistry Laboratory (2) spring
Continuation of Chem 53 with particular emphasis upon aromatic compounds and qualitative organic analysis. Prerequisite: Chem 53 previously; Chem 52 concurrently. Mr. Heindel, Mr. Schray or Mr. Young.

55. Organic Chemistry Laboratory (2) spring
A course in the preparation of pure organic compounds and the techniques of organic chemistry applicable to both aliphatic and aromatic compounds. Prerequisites: Chem 51 and Chem 52 concurrently. Mr. Heindel, Mr. Schray or Mr. Young.

187. Physical Chemistry (3) spring
Development of the principles of thermodynamics and their application to systems in which composition is of major concern: solutions, chemical and phase equilibria. Elements of chemical reaction kinetics. Discussion of various states of matter (gases, liquids, solids, interfaces). Prerequisites: Chem 31, or Met 210, and Math 21 or 43 previously or concurrently. Mr. Lovejoy or Mr. Zeroka.

188. Physical Chemistry Laboratory (2) fall
Primarily for majors in chemistry. Quantitative observation of properties of matter and of dynamic processes involving composition, the relation of observations to conceptual models. Methods of data acquisition, treatment, assessment. Two three-hour labs per week. Prerequisite: Chem 187. Mr. Sturm.

191. Physical Chemistry (3) fall
Quantum chemistry of bonding and molecular structure. Elements of statistical thermodynamics. Prerequisites: Chem 21, Math 23, Phys 21. Mr. Lovejoy or Mr. Zeroka.

192. Physical Chemistry Laboratory (2)
This course provides a series of laboratory studies which illustrate the various fields of study in experimental physical chemistry. Prerequisite: Chem 187. Mr. Sturm.

Fig. 1798.
MINARET IN ALEXANDRIA.
(Used as a marine telegraph.)

193. Environmental Science Seminar (Biol 191, Geol 191) (1) fall and spring
Current developments in environmental science presented by students and discussed in seminar style. An interdisciplinary approach linking biological, geological and chemical principles as they relate to causes and controls of environmental problems. May be taken more than once for credit. Prerequisite: sophomore standing. Mr. Hughes.

194. Physical Chemistry for Biological Sciences (3) spring
The principles and applications of physical chemical concepts to systems of biological interest, including the gas laws, thermodynamics of metabolic reactions, colligative properties, electrochemical equilibria, reaction kinetics and enzyme catalysis, and transport of macromolecules and viruses. Prerequisite: Chem 21. Messrs. Fowkes and Schaffer.

234. Analytical Chemistry Laboratory (1)
Laboratory course: experiments coordinated with and illustrating methods and principles discussed in Chem 332. Messrs. Hughes, Ohnesorge and Rodgers.

250. Special Topics (1-3)
Selected topics in chemistry. May be repeated for credit when different topics are offered.

300. Apprentice Teaching in Chemistry (1-3)

303. Nuclear and Radiochemistry (3)
A broad survey of nuclear science with particular emphasis on aspects of importance to chemistry and biology. Elementary nuclear theory; production, separation, and identification of radioactive and stable isotopes; use of isotopes in the study of chemical and biological systems; radiological safety; nuclear engineering. Two lectures and one lecture-laboratory. Mr. Sturm.

307. Advanced Inorganic Chemistry (3) spring
Selected topics in inorganic chemistry. Descriptive chemistry of the representative elements; introduction to transition metal complexes and the theories of bonding in these substances; kinetics and mechanisms of transition metal complex reactions; selected aspects of organometallic chemistry; bioinorganic chemistry. Prerequisite: Chem 191. Mr. Kraihanzel or Mr. Sprague.

310. Instrumentation Principles I (3) fall
Introduction to electronic instrumentation. Operational amplifiers and instrument design. Laboratory includes the design and construction of a useful electronic instrument of student's choice. Typical project possibilities: EKG amplifier; simple calorimeter; pH meter; lock-in amplifier; analog computer for solving equations of state; electrochemical waveform generator. No prior electronics experience needed. Two lectures and one three-hour laboratory. Mr. Rodgers.

311. Instrumentation Principles II (3) spring
A continuation of Chem 310 emphasizing digital electronics. Digital-analog and analog-digital conversion. Introduction to microprocessors and microcomputers. The laboratory includes a design and construction project. Typical project possibilities include an alphanumeric oscilloscope display interface and a hardware multiply/divide unit for a microprocessor. Two lectures and one three-hour laboratory. Prerequisite: Chem 310 or equivalent with permission of department chairman. Mr. Rodgers.

312. (ChE 312, Met 312) Fundamentals of Corrosion (3) fall
Corrosion phenomena and definitions. Electrochemical aspects including reaction mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization, and passivity. Nonelectrochemical corrosion including mechanisms, theories, and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisites: Met 210, Chem 187, or equivalent. Mr. Leidheiser or Mr. Smyth.

332. Analytical Chemistry (3) fall
Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry; interpretation of numerical data, design of experiments, solute distribution in separation methods. Prerequisites: Chem 31 and 51. Mr. Ohnesorge or Mr. Rodgers.

334. Chemical Oceanography (3)
Chemistry of the oceans and other natural water systems, with emphasis on processes occurring at the interfaces with the air, the sediments, the rivers, and living organisms. Optional cruise. Prerequisite: two chemistry courses or consent of department chairman.

336. Clinical Chemistry (3) spring
Applications of analytical chemistry to clinical problems. Discussion of methods in common use and the biochemical-medical significance of the results. Prerequisites: Chem 39 or Chem 332 and Chem 52. Messrs. Ohnesorge and Rice.

350. Special Topics (1-3)
Selected advanced topics in chemistry. May be repeated for credit when different topics are offered.

356. Advanced Analytical Chemistry Laboratory (1) fall or spring
Laboratory coordinated with Chem 23, 334 or 336 illustrating development and use of instrumental methods of analysis. Prerequisite: Chem 39, or Chem 234 (which may be taken concurrently) and permission of department chairman. Messrs. Hughes, Ohnesorge and Rodgers.

358. Advanced Organic Chemistry (3) fall
The study of modern theories of reaction mechanisms and their applications to the problems of organic chemistry. Prerequisite: one year of organic chemistry. Mr. Heindel or Mr. Young.

368. Advanced Organic Laboratory (2)
The synthesis and study of organic compounds illustrating the important techniques and special pieces of apparatus commonly used in organic chemical research. Prerequisite: one year of organic chemistry and laboratory.

371. (Biol 371) Elements of Biochemistry I (3) fall
A general study of carbohydrates, proteins, lipids, nucleic acids, and other biological

substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Prerequisite: one year of organic chemistry. Mr. Merkel or Mr. Schaffer.

372. (Biol 372) Elements of Biochemistry II (3) spring
Dynamic aspects of biochemistry: enzyme reactions including energetics, kinetics, and mechanisms; metabolism of carbohydrates, lipids, proteins, and nucleic acids; photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules. Prerequisite: Chem 371. Mr. Merkel or Mr. Schaffer.

375. Research Chemistry Laboratory (3) fall-spring
Advanced independent study or an investigation involving intensive work with faculty guidance in laboratory and library. Topics in active research in biochemistry, analytical, inorganic, organic, and physical chemistry. Prerequisite: consent of department chairman.

377. Biochemistry Laboratory (3) fall
Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals. Prerequisite: Chem 371, previously or concurrently. Mr. Merkel or Mr. Schaffer.

378. Biochemical Preparations (2) spring
A laboratory course involving the preparation or isolation, purification and identification of chemicals of biological origin. Prerequisites: Chem 377 and 372, previously or concurrently. Messrs. Merkel and Schaffer.

381. Radiation and Structure (3) fall
Quantum chemistry and group theory applied to molecular orbital theory of bonding and structure and to spectroscopy: X-ray, electron, luminescence, Raman, microwave. Prerequisites: Chem 191 and 332. Messrs. Klier, Ohnesorge and Zeroka.

382. Electrochemistry and Kinetics (3-4)
A unified study of matter in the process of change. Elements of irreversible thermodynamics; electrochemistry; chemical kinetics; electrokinetic phenomena. Three one-hour lectures and (optional) three-hour laboratory. Prerequisites: Chem 187 and 332. Mr. Sturm.

383. Advanced Chemical Experimentation (4) spring
An advanced lecture-laboratory course which requires the student to interrelate and coordinate facts and experimental techniques covered in prior chemistry courses. This correlation is utilized by the student in synthesis, separation, purification, characterization, and analysis of selected organic and inorganic compounds. One lecture and three laboratory meetings per week. Prerequisites: Chem 188 and Chem 307 previously or concurrently. Mr. Kraihanzel.

390. Polymer Synthesis and Characterization (3) spring
Techniques include: free radical and condensation polymerization; molecular weight distribution by gel chromatography; crystallinity and order by differential scanning calorimetry; pyrolysis and gas chromatography; dynamic mechanical and dielectric behavior; morphology and microscopy; surface properties; Prerequisites: Chem 187, Chem 191, and Chem 51. Mr. Manson.

392. (ChE 392) Introduction to Polymer Science (3)
Introduction to concepts of polymer science. Kinetics and mechanism of polarization; synthesis and processing of polymers, characterization. Relationship of molecular conformation, structure and morphology to physical and mechanical properties. Prerequisite: Chem 187 or equivalent.

393. (ChE 393, Met 343) Physical Polymer Science (3) fall
Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline, and paracrystalline states (including viscoelastic and relaxation behavior) for single and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology and behavior. Prerequisite: one year of physical chemistry.

394. (ChE 394) Organic Polymer Science (3) spring
Organic chemistry of synthetic high polymers. Functionality and reactivity of monomers and polymers. Theory of stepgrowth and chain-growth polymerization in homogeneous and heterogeneous media. Polymerization by addition, elimination, substitution, and coupling reactions. Ionic, free-radical, and coordination catalysis. Prerequisite: one year of physical chemistry and one year of organic chemistry. Messrs. Manson and Vanderhoff.

395. Colloid and Surface Chemistry (3) fall
Physical chemistry of everyday phenomena. Intermolecular forces and electrostatic phenomena at interfaces, boundary tensions and films at interfaces, mass charge transport in colloidal suspensions, electrostatic and London forces in disperse systems, gas adsorption, and heterogeneous catalysis. Prerequisite: Chem 187 or equivalent. Mr. Fowkes.

396. Chemistry of Nonmetallic Solids (3) spring
Chemistry of ionic and electronic defects in nonmetallic solids and their influence on chemical and physical properties. Intrinsic and impurity controlled defects, nonstoichiometric compounds, defect interactions. Properties to be discussed include: diffusion, sintering, ionic and electronic conductivity, solid-state reactions, and photoconductivity. Prerequisite: Chem 187 or Met 210 or equivalent. Mr. Smyth.

Graduate program

The department of chemistry offers graduate studies leading to several advanced degrees. In addition to the traditional master of science and doctor of philosophy degrees in chemistry, the department also offers a doctor of arts degree in chemistry (primarily for college-level chemistry teachers), an M.S. and Ph.D. degree in physiological chemistry (primarily for certain specialties in the health sciences), and an M.S. and Ph.D. degree in molecular biology.

Most of the chemistry facilities are housed in the 90,000 square foot Chemistry Complex, first occupied in 1975. The seven-story Seeley G. Mudd Building affords laboratory space of modern design; the top three floors are devoted to research laboratories. Most of the research laboratories in the adjacent Sinclair Laboratory are assigned to chemistry professors who specialize in research in surface and colloid chemistry.

Physiological chemistry research is located in Chandler-Ullmann Hall and in the Seeley G. Mudd Building. Solid-state chemical research is located in the new Sherman Fairchild Solid State Studies Laboratory, in Coxe Laboratory, in the Seeley G. Mudd Building, and in Sinclair Laboratory. Polymer chemistry research laboratories are located in Coxe Laboratory, Sinclair Laboratory, and the Seeley G. Mudd Building.

The university libraries contain approximately 650,000 volumes and subscribe to some 6,000 serials and periodicals. There are particularly strong collections available for research in the physical and natural sciences.

The graduate program in chemistry at Lehigh has a two-fold purpose. It affords a student the opportunity to acquire an advanced knowledge of chemistry within the framework of formal graduate courses and permits the development of techniques required of competent research through independent scientific investigation. The graduate program for the Ph.D. degree in chemistry consists of approximately one-third formal course work and two-thirds independent research and study. A student entering upon graduate study with a teaching assistantship spends an average of four years of full-time residency beyond the bachelor's degree to complete all the requirements for the Ph.D. degree.

During the first year of graduate work, a student normally takes basic graduate courses from the fields of analytical, biological, inorganic, organic, and physical chemistry and becomes acquainted with the research interests of the various faculty members. From these contacts the student is able to assess critically an individual research interest, and thus choose a research director. Having selected a research director, a research problem is mutually agreed upon; a thesis committee is appointed to serve in an advisory capacity.

It is assumed that an entering graduate student in chemistry has satisfied the requirements for the bachelor's degree that meet the minimum standards recommended by the American Chemical Society committee on professional training. Thus, in addition to the usual chemistry courses, a student's undergraduate curriculum should include at least one year of physics, mathematics through calculus, and preferably at least one year of German. If a deficiency is shown in one or more of these undergraduate areas, these can be rectified during the first year of graduate work and will not affect a student's eligibility for an appointment to an assistantship.

Teaching and research assistantships, as well as fellowships, are available to graduate students in chemistry. The assistantships are regarded as half-time appointments, permitting a student to enroll for up to ten credit hours of course work per semester. Students on teaching appointments normally have an average of eight hours per week of instructional duties in undergraduate recitation classes or laboratories.

The university does not charge tuition or other fees of students on teaching appointments.

Sixty-five students are enrolled in graduate studies in chemistry. About twenty have teaching assistantships, sixteen have research assistantships, six have fellowships, and twenty are part-time students working in local industrial laboratories. Usually there are more research assistantships available than applicants. The students on research assistantships tend to progress faster towards their degrees than those who are teaching assistants and they become educated in subjects of more interest to potential employers.

The department had $750,000 of research funding in 1975-76, mostly in research on polymers, surface and colloid chemistry, catalysts and solid state chemistry, physiological, organic, biochemical, and pharmaceutical chemistry. Students specializing in these fields will have the best chance of research assistantships during 1977-79. Several fellowships in energy-related research, especially catalysis, are also available.

Current research projects of interest are listed below.

Analytical chemistry. Electrochemical reduction and oxidation mechanisms of organic compounds, luminescence of metal chelates, voltammetry in nonaqueous solvents, clinical-biomedical applications, mechanisms of electrode processes, adsorption, chemistry of amalgams, metal-organic interactions in the environment; environmental analytical chemistry (electrochemical, atomic absorption and chromatographic techniques); redox behavior of transition metal complexes.

Biochemistry. Production, isolation and characterization of proteolytic enzymes of marine bacteria; determination of the amino acid specificity of bacterial proteases; mechanism of action of proteolytic enzymes, cardiac metabolism and enzymology; enzyme kinetics; protein structure and reconstitution; sugar phosphate substrate utilization by glycolytic enzymes; mechanism of phosphoglucose isomerase and aldolase; phosphoryl transfer reactions of enzyme.

Inorganic chemistry. Synthesis and characterization of amide complexes of transition metals; silicon organometallic compounds; substitution and rearrangement reactions involving metal carbonyls; organic syntheses and catalysis involving transition metal complexes.

Organic chemistry. Synthesis of medicinal agents; correlation of molecular structure with pharmacological behavior; chemical models for biochemical reactions; sulfur bonding in novel heteroaromatic sulfur compounds; biosyntheses involving indole intermediates; mechanism of formation and structure of melanin; synthesis of new heterocyclic systems; mechanisms of phosphoglucose isomerase and aldolase; synthesis and phosphoryl transfer of phosphate esters of biological interest.

Physical chemistry. Lehigh operates one of the half-dozen leading laboratories in the world in surface and colloid chemistry and students in these specialties have many employment opportunities. Research areas include latex research, surface coatings, colloidal stability, adhesion, surface properties of catalysts, surface spectroscopy, surface colorimetry, and ice nucleation. Solid state chemistry is also outstanding and includes studies of point defects in oxides, oxide growth, and surface spectroscopy. Other fields include flash photochemistry and kinetic spectroscopy, structure determination (bond lengths and angles) of gaseous compounds from vibration-rotation spectra using infrared spectroscopy, and applications of quantum mechanics and statistical mechanics to problems of chemical interest.

Polymer chemistry. Lehigh staff members are recognized nationally and internationally in several aspects of the synthesis, structure, conformation, and properties of high polymers: techniques and kinetics of emulsion polymerization and film formation; acoustic, optical, permeability, dielectric, and mechanical behavior of thin films, coatings and bulk polymers; molecular structure, relaxation behavior, and energetics of fracture; elastic and viscoelastic behavior of interpenetrating and rubbery networks; effects of ordering in the glassy state and crystallization on physical properties; crystallization under the influence of shear gradients; physical chemistry of polymer composites such as polymer-concrete and filled polymers; interfacial characteristics and interactions in polymer-inorganic systems. Students specializing in polymer research at Lehigh have many employment opportunities today.

Special equipment available for graduate research in chemistry includes a computer terminal in the Chemistry Complex, electron microscope, scanning electron microscope, electron microprobe, optical microscopes, precision mass spectrometer, nuclear magnetic resonance spectrometer, electron spin resonance spectrometer, various double-beam infrared, visible, and ultraviolet spectrometers, Fourier transform infrared interferometer, atomic absorption spectrometers, spectrofluorometers, phosphorescence spectrometer, Auger spectrometer, Mossbauer spectrometer, automatic multichannel scintillation counter, radiotracer equipment, flash photolysis apparatus, light-scattering photometer, ultracentrifuges, analytical and preparative gas chromatographs, Vibron elastoviscometer, Weissenberg rheogoniometer, differential scanning calorimeter and other thermoanalytical equipment, gel permeation chromatograph, torsional modulus apparatus, vapor and liquid permeability equipment, dielectric capacitance bridges, MTS closed-loop hydraulic tester, torsion tensile testers, high temperature tube furnaces, capacitance-voltage testing equipment, cobalt-60 gamma ray source, Wenking potentiostat, recording-multipurpose polarographs, and chronopotentiometers, high speed centrifuges, automatic fraction collectors, freeze dryers, high-voltage electrophoresis apparatus, laboratory fermentor, walk-in cold room, cell disintegrator, Warburg respirometer, zone and disc electrophoresis apparatus, paper column chromatography equipment, autoclave.

Graduate courses in chemistry

402. Physical Inorganic Chemistry (3) alternate years
Theories of bonding. Group theoretical principles will be utilized in studies of molecular orbital and ligand field theories of bonding. Prerequisite: Chem 191 or equivalent. Mr. Klier.

403. Advanced Topics in Inorganic Chemistry (1-3) alternate years
Topics of contemporary interest in inorganic chemistry. This course may be repeated when a different topic is offered. Prerequisite: Chem 307 or equivalent. Messrs. Klier, Kraihanzel and Sprague.

405. Organometallic Chemistry (3) alternate years
The chemistry of compounds containing carbon to metal bonds. Among topics covered are the following: organic compounds of the representative elements from Groups I-IV; the chemistry of ferrocene and related pi-bonded organometallic complexes; metal carbonyl and nitrosyl complexes; dioxygen and dinitrogen complexes; organic syntheses utilizing organometallic catalysts. Prerequisites: Chem 307 and Chem 358. Mr. Kraihanzel.

407. Mechanisms of Inorganic Reactions (3) alternate years
A study of the experimental and theoretical evidence for the following types of inorganic reaction mechanisms: proton transfer and Bronsted acid-base catalysis, nucleophilic and electrophilic displacements, Lewis acid-base catalysts, electron and atom transfer in oxidation-reduction reactions, free radical reactions, elimination reactions. Emphasis is on homogenous reactions in solution or the gas state. Mechanisms involving both transition and nontransition elements are discussed. Prerequisite: Chem 307 or equivalent. Mr. Kraihanzel.

411. Teaching Internship (3-6) fall-spring
The preparation, teaching and grading of one or two undergraduate lecture courses with appropriate supervision by senior faculty. Observation and evaluation of the intern is effected by classroom visits and videotape review. Prerequisite: candidacy in the doctor of arts program or permission of the department chairman. May be repeated for credit.

421. Chemistry Research (1-6)
Research in one of the following fields of chemistry: analytical, inorganic, organic, physical, polymer, biochemistry.

423. Bio-organic Chemistry (3) alternate years
An examination of biochemistry on the basis of organic chemical principles. Emphasis on reaction mechanisms of biochemical transformations and methods for elucidation of these mechanisms, i.e. kinetics, isotope effects, exchange techniques, inhibition studies, substrate analog effects, and organic model studies. Prerequisite: Chem 358. Mr. Schray.

424. Medicinal and Pharmaceutical Chemistry (3) alternate years
Principles of drug design, structure-activity relationships in antibacterial, antimalarial, anti-inflammatory, and psychoactive drugs; syntheses and modes of action of pharmacologically active agents, radioactive pharmaceuticals. Prerequisite: one year of organic chemistry. Mr. Heindel.

432. Advanced Analytical Chemistry (3) alternate years
Recent developments in analysis by chemical methods. Statistical methods in analytical chemistry: treatment and interpretation of numerical data; design of experiments; application to and discussion of multistage and other methods for separating chemical species. Prerequisite: Chem 332 or equivalent. Messrs. Hughes, Ohnesorge and Rodgers.

Fig. 1505. — ROMAN LAMPS.

433. Advanced Topics in Electrochemistry (3) alternate years
Theory and applications of selected electrochemical techniques; solutions to mass transport problems, treatment of electron transfer kinetics and kinetics of associated chemical reactions, and critical evaluation of adsorption and other factors associated with electrochemical processes. Prerequisite: Chem 332 or equivalent. Mr. Rodgers.

436. Special Topics in Analytical Chemistry (1-3)
Topics of contemporary interest in analytical chemistry. May be repeated for credit when a different topic is offered. Messrs. Hughes, Ohnesorge and Rodgers.

441. Chemical Kinetics (3) alternate years
A study of kinetic processes. Phenomenological chemical kinetics; order, mechanism effect of external variables on rate. Theories of the rate constant. Relation between theromodynamics and kinetics. Applications to selected systems such as unimolecular decompositions, adsorption and catalysis. Prerequisite: one year of physical chemistry. Mr. Sturm.

443. (Met 433) Solid State Chemistry (3) alternate years
Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids, dielectrics, surface states and surface fields in crystals. Prerequisite: one course in linear algebra and one course in quantum mechanics. Mr. Klier.

445. Elements of Physical Chemistry (4) fall
Quantum chemistry of simple systems, molecular structure and spectroscopy, statistical and classical thermodynamics, and principles of kinetic processes. Messrs. Lovejoy, Sturm and Zeroka.

447. (Biol 447) Experimental Molecular Biology (3)
A survey of current research in molecular biology.

451. Theoretical Organic Chemistry (3) alternate years.
Advanced theoretical and mechanistic organic chemistry with emphasis on molecular orbital and group theoretical treatments of structure, spectra, and reactivity of pi-electron systems. Typical applications include conservation of orbital symmetry in pericyclic reactions, and studies of electrophilic, nucleophilic, and homolytic substitution reactions of aromatic compounds. Mr. Young.

453. Heterocyclic Compounds (3) alternate years
An intensive study of the syntheses, reactions and properties of heteroaromatic compounds including derivatives of thiophene, pyrrole, furan, indole, pyridine, quinoline, the azoles and the diazines; all considered from the viewpoint of modern theories of structure and reaction mechanisms. Prerequisite: Chem 358. Mr. Young.

458. Topics in Organic Chemistry (1-3)
An intensive study of limited areas in organic chemistry. May be repeated when a different topic is offered. Messrs. Young, Heindel and Schray.

466. Advanced Organic Preparations (2-3)
A laboratory course of instruction in advanced techniques of the preparation of organic compounds.

476. Microbial Biochemistry (3)
Composition, nutrition and metabolism of micro-organisms, with emphasis on microbial enzyme reactions and products of microbial metabolism. Prerequisites: Chem 372 and Biol 35 or equivalents. Mr. Merkel.

477. Topics in Biochemistry (1-3)
Selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins. May be repeated for credit when different topics are offered. Prerequisite: consent of department chairman. Messrs. Schaffer and Merkel.

479. Biochemical Techniques (1-3)
Laboratory studies of the techniques and principles involved in the isolation, identification and biochemical transformation of carbohydrates, lipids, nucleic acids and proteins. Prerequisite: Chem 371 or its equivalent, previously or concurrently. Messrs. Merkel and Schaffer.

480. Advanced Biochemical Preparations (1-3)
An advanced laboratory course in the preparation, isolation, purification and identification of biochemically produced materials. Emphasis is placed on materials and procedures of current interest in biochemistry. Prerequisite: consent of department chairman. Messrs. Merkel and Schaffer.

481. Chemistry Seminar (1-6) fall-spring
Reports and discussions of recent developments in chemistry.

482. (ChE, Met 482) Engineering Behavior of Polymers (3) spring
Mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture and aging on mechanical behavior.

483. (ChE 483) Emulsion Polymers (3) fall
Fundamental concepts important in manufacture, characterization, and application of polymer latexes. Topics will include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation, and various application problems. Prerequisite: previous course in polymers.

484. (ChE, Met 484) Crystalline Polymers (3) spring
Morphology and behavior of both polymer single crystals and bulk crystallized systems. Relationship between basic crystal physics, thermal and annealing history, orientation and resulting properties. Thermodynamics and kinetics of transition phenomena and a brief treatment of hydrodynamic properties and their relationship to crystallization and processing properties.

485. (ChE, Met 485) Polymer Blends and Composites (3) fall
Synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated solids and fiber and particulate-reinforced polymers are emphasized. Prerequisite: any introductory course in polymers.

492. (ChE 492) Topics in Polymer Science (3)
Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered. Prerequisite: Chem 392 or equivalent.

494. Quantum Chemistry (3) alternate years
Principles and applications of quantum mechanics to chemical problems. Applications to chemical bonding, molecular structure, reactivity and spectroscopy. Prerequisite: Chem 445 or consent of department chairman. Mr. Zeroka.

495. Statistical Thermodynamics (3) alternate years
Principles and applications of statistical mechanics to chemical problems. A study of the techniques for evaluating the properties of matter in bulk from the properties of molecules and their interactions. Mr. Zeroka.

497. Topics in Colloid and Surface Chemistry (3)
Applications of colloid chemistry; special topics in surface chemistry. Lectures and seminar. Prerequisite: Chem 397. May be repeated for credit as different topics are covered. Messrs. Fowkes, Micale, Vanderhoff and Zettlemoyer.

498. Advanced Topics in Physical Chemistry (1-3)
Advanced topics in physical chemistry, such as photochemistry and radiation chemistry, Fourier transform spectroscopy, kinetics of rapid reactions, theory of magnetic resonance. May be repeated for credit when different topics are offered.

CIVIL ENGINEERING

Professors. David A. VanHorn, Ph.D., Chairman; Lynn S. Beedle, Ph.D., Director, Fritz Laboratory; Wai-Fah Chen, Ph.D.; J. Hartley Daniels, Ph.D.; George C. Driscoll, Jr., Ph.D.; Hsai-Yang Fang, Ph.D.; John W. Fisher, Ph.D.; Ti Huang, Ph.D.; John O. Liebig, Jr., M.S.; Le-Wu Lu, Ph.D.; Alexis Ostapenko, Ph.D.; Adrian F. Richards, Ph.D.; Roger G. Slutter, Ph.D.; Lambert Tall, Ph.D.

Associate professors. Arthur W. Brune, Ph.D.; George A. Dinsmore, M.S.; Terence J. Hirst, Ph.D.; Robert L. Johnson, Ph.D.; Celal N. Kostem, Ph.D; Bung-Tseng Yen, Ph.D.

Assistant professors. Willard A. Murray, Ph.D.; Paul J. Usinowicz, Ph.D.; Richard N. Weisman, Ph.D.; Nicholas Zettlemoyer, Ph.D.

Civil engineering, the stem from which have branched the other types of engineering, is concerned with projects which contribute to the comfort and needs of the human race.

The professional practice of a civil engineer includes the conception, design, construction, operation, and maintenance of private and public projects, including bridges, buildings, highways, airports, railroads, harbors, docks, subways, tunnels, water supply and purification systems, sewage collection and treatment facilities, water power developments, the making of surveys, and research.

Many civil engineers are associated with consulting engineering firms, contractors, industrial concerns, or various governmental agencies.

In the undergraduate program, the work of the first two years deals chiefly with the scientific and mathematical principles which form the bases of engineering practice. The last two years include the applications of these principles, along with opportunities for elective courses in areas of individual interest. All students receive instruction in engineering measurements, soil mechanics, fluid mechanics and hydraulics, structural theory and design, transportation engineering and environmental engineering.

Engineers, through their professional societies, have urged that the engineering student be educated as a professional person with a sound understanding of one's place in society. This education is provided through a well-planned civil engineering program enriched by the humanistic-social courses taken during the four years, and selected with the advice and approval of the curriculum director.

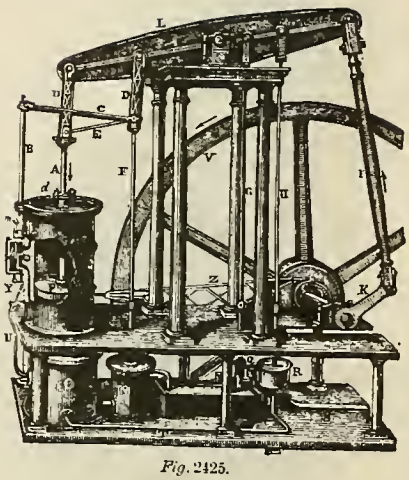

Fig. 2425.

Recommended sequence of courses

freshman year (See page 40.)

sophomore year, first semester (15 credit hours)

Math 23	Analytic Geometry & Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Lab II (1)
Mech 1	Statics (3)
CE 9	Civil Engineering Computations (1)
CE 11	Engineering Graphics (2)

sophomore year, second semester (16)

Math	Elective (3)
CE 40	Surveying Principles I (3)
Eco 1	Economics (4)
Mech 11	Mechanics of Materials (3)
Met 92	Structure and Properties of Materials (3)

summer (3 credit hours)

CE 41	Surveying Principles II (3)

junior year, first semester (17)

CE 109	Numerical Techniques (2)
CE 121	Mechanics of Fluids (3)
CE 159	Structural Analysis I (3)
CE 143	Soil Mechanics (3)
	General Studies requirement (3)
	elective (3)

junior year, second semester (15-18)

Mech 104	Dynamics and Vibrations (3)
CE 170	Environmental Engineering I (3)
CE 160	Structural Design (3)
CE 222	Hydraulic Engineering (3)
	General Studies requirement (3)
	elective (0-3)*

summer

CE 100	Industrial Employment

senior year, first semester (15-18)

CE 203	Professional Development (3)
CE 207	Transportation Engineering (3)
CE 200	Engineering Planning (3)
	General Studies requirement (3)
	elective (3-6)*

senior year, second semester (15-18)

	General Studies requirement (3)
	elective (12-15)*

*Please refer to description of normal program, page 40.

Elective opportunities total 18 to 27 credits, with at least six credits to be in engineering science courses and at least three in engineering design. Lists of appropriate engineering science and engineering design courses are available in the offices of the civil engineering department.

Undergraduate courses

9. Civil Engineering Computations (1) fall
Applications of computer concepts to civil engineering problems. Prerequisite: Engr 1 or equivalent computer coverage.

11. Engineering Graphics (2) fall
Use of drawing instruments; freehand lettering and shape description; theory of orthographic projection, revolution, and pictorial representation; theoretical problems in space relationships between points, lines and planes; surfaces as loci. Emphasis on visualization and geometric logic. Mr. Dinsmore.

40. Surveying Principles I (3) spring
Study of the sources, magnitude, effects and removal of systematic errors and reduction of random errors in linear and angular measurements; effect of errors on computations. Care of and field techniques with the steel tape, engineers transit and engineers level. Study of linear measurements, differential leveling, direction of lines, the compass, angular measurements, traverse surveys and calculations; stadia, topographic surveys, horizontal and vertical curves. Field and office work. Messrs. Liebig and Slutter.

41. Surveying Principles II (3) summer
Field astronomy including office procedures to obtain latitude and true direction from observation on the sun and Polaris. Land, topographic, and engineering surveys, including map compilation and drawing of plan, profile, and cross-sections; coordinate systems, earth work, compound, spiral and parabolic curves. Daily recitations and field work for a three-week period. Prerequisite: CE 40. Messrs. Liebig and Slutter.

100. Summer Employment
During the summer following the junior year, students spend at least eight weeks in practical work, preferably in the field which the individual plans to enter after graduation. A written report on the experience obtained is due on return from summer vacation. Prerequisite: senior standing.

104. Readings in Civil Engineering (1-3)
Study of selected technical papers, with abstracts and reports. Prerequisite: consent of department chairman.

106. Structural Design (3) spring
Elementary theory and design of structures in steel, wood, and concrete. An abridged course in stress analysis and design for students other than civil engineers. Prerequisite: Mech 11.

109. Numerical Techniques (2) fall
Computerized solution of civil engineering problems, predicated on numerical techniques. Prerequisite: CE 9.

121. Mechanics of Fluids (3) fall
Fluid properties and statics; concepts and basic equations for fluid dynamics. Forces caused by flowing fluids and energy required to transport fluids, with emphasis on pipe flow. Dynamic similitude and modeling of fluid flows. Includes laboratory experiments to demonstrate basic concepts. Prerequisite: Mech 1. Messrs. Murray and Brune.

123. Fluid Mechanics Laboratory (1) spring
Exercises in closed conduit flow, open-channel flow, and hydraulic machinery. Prerequisite: CE 121 or ME 231.

143. Soil Mechanics (3) fall
Fundamental physical, chemical and mechanical properties affecting the engineering behavior of soils. Identification; classification; permeability; effective stress and pore water pressures; compaction, compression and consolidation; stress-strain behavior and shear strength; laboratory tests for engineering properties; application of theories and principles in engineering practice. Prerequisite: Mech 11 or consent of department chairman.

157. Concrete Laboratory (1) fall
Principles of the behavior of plain and reinforced concrete. Design and preparation of concrete mixtures, and tests of aggregates, control cylinders, and reinforced concrete beams. Prerequisite: CE 160 previously or concurrently.

159. Structural Analysis I (3) fall
Elastic analysis of statically determinate frames and trusses; deflections by the method of virtual work; force method analysis of indeterminate structures; moment distribution concept. Prerequisite: Mech 11.

160. Structural Design (3) spring
Principles of structural design. Safety and economy. Strength, stability and serviceability criteria. Selection of simple structural members to resist tensile, compressive, bending, and shearing loads. Various structural materials will be covered, especially steel and reinforced concrete. Prerequisite: CE 159.

170. Environmental Engineering I (3) spring
Quantitative analysis of water sources. Analysis and design of transmission and distribution of water; collection of wastewater and stormwater. Demonstration laboratories for water and wastewater treatment processes. Prerequisite: CE 121. Messrs. Johnson and Usinowicz.

200. Engineering Planning (3) fall
Principles of systems planning of civil engineering projects. A study of factors affecting the inception, evaluation, planning, design and completion of typical engineering projects, including technical, political, economic, social and environmental factors; urban planning; plan implementation; decision making; management techniques and reporting; optimal principles. Prerequisite: senior standing. Messrs. Daniels and Dinsmore.

203. Professional Development (3) fall
Elements of professionalism, unionization of engineers, professional ethics, engineering registration; role and characteristics of professional and technical societies; the civil engineer's responsibilities as a professional and citizen, continuing education, and the role of management and law in engineering. Written and oral reports. Prerequisite: consent of department chairman. Mr. Liebig.

205. Design Problems (1-6)
Supervised individual design problems, with report. Prerequisite: consent of department chairman.

207. Transportation Engineering I (3) fall
Principles of the design of transportation facilities with emphasis on highways and airports in the areas of geometric, drainage, and pavement design. Design problems. Prerequisites: CE 41, senior standing. Messrs. Liebig and Slutter.

211. Research Problems (1-6)
Supervised individual research problems, with report. Prerequisite: consent of department chairman.

222. Hydraulic Engineering (3) spring
Hydraulic measurements, hydraulic machinery, hydraulic structures, open-channel flow, transport of sediments, coastal engineering. Includes laboratory experiments in applied hydraulics. Prerequisite: CE 121 or equivalent. Messrs. Brune and Murray.

244. Foundation Engineering (3) spring
Application of the theories and principles of soil mechanics to foundation design. Site investigations and engineering tests to evaluate subsoil conditions. Bearing capacity and settlement analyses for building foundations. Lateral loads on retaining walls and bulkheads. Slope stability and embankment design. Seepage. Prerequisite: CE 143 or consent of department chairman. Mr. Fang.

259. Structural Analysis II (3)
Deflection of beams and frames by moment area methods; force analysis of complex structures; plastic analysis by mechanism methods; influence coefficients; introduction to displacement methods of analysis; computer applications. Prerequisite: CE 159.

261. Structural Steel Design (3) fall
Design of steel structures, including plate girders, other built-up members, trusses, frames, grillages, shell-type structures and thin gage members. Additional topics include connections, composite beams, and fatigue and fracture concepts related to structural design. Prerequisite: CE 160. Mr. Tall.

263. Structural Concrete Design (3) fall
Design of reinforced concrete structural

elements and basic systems, including continuous beams, frames, slabs, footings, and walls. Serviceability criteria. Introduction to prestressing and torsion. Prerequisite: CE 160. Messrs. Daniels and VanHorn.

271. Environmental Engineering II (3) fall
Introduction to unit operations and unit processes involved in water and waste water treatment facilities. Consideration of combinations to meet water quality requirements, either as water supply source or as receiving mantle. Prerequisite: CE 170. Mr. Usinowicz.

280. Internship (3)
Individual opportunities for qualified advanced civil engineering students to obtain practical experience through association with civil engineers, architects and planners. Typical fields of practice include transportation, hydraulic engineering, environmental engineering, air pollution, regional and city planning, architectural planning, and public works engineering. Prerequisite: senior standing. May be repeated once for credit.

300. Apprentice Teaching CE (1-3)

309. Computer Programming (2) fall
Advanced concepts of Fortran programming in analysis and design. Emphasis on logical program requirements for proper and efficient execution. Addressing and dynamic core allocation. Use of compiler maps and loader maps. Prerequisite: CE 109 or consent of department chairman.

316. Civil Engineering Planning (3)
Project-oriented planning of one or two civil engineering projects of students' choice, with oral and written report; task force approach, collection and analysis of data; consideration of technical and environmental factors; cost analyses. Interaction with consulting engineers and planners. Prerequisite: senior standing or consent of department chairman.

322. Hydromechanics (3)
Fundamental equations of fluid flow. Stress on viscous flow with introductions to turbulence, boundary layers, and turbulent shear flow. Hydraulic applications. Prerequisites: Math 205, CE 121.

323. Hydraulic Laboratory Practice (1-3)
Study of theory and methods of hydraulic experimentation.

324. (Mech 323) Fluid Mechanics of the Ocean and Atmosphere (3)
Hydrostatics of the ocean and atmosphere. Vertical stability. Fluid motion in a rotating coordinate system. Geostrophic flow; ocean currents; surface and internal waves. Prerequisite: ME 231 or CE 121. Mr. Macpherson.

325. Hydrology (3) fall
Hydrologic cycle. Precipitation, evaporation, transpiration, infiltration. Ground water. Stream flow, hydrographs, floods. Statistical analysis applied to hydrology. Prerequisite: CE 121 or equivalent. Mr. Brune.

326. Ground Water Hydrology (3) spring
The study of subsurface water, its environment and distribution. Theory of ground water movement. Mechanics of well flow. Sea water intrusion. Artificial recharge. Basin development. Prerequisite: CE 121 or consent of department chairman. Mr. Murray.

328. Channel and Oceanographical Hydraulics (3) fall
Hydraulics of fixed bed channels, specific energy concept, secondary current, frictional resistance, flow stability, artifical obstruction. Oceanographical engineering and coastal hydraulics, theory of waves, wave forces, wave refraction and diffraction, coastal processes. Prerequisites: CE 121 and consent of department chairman. Mr. Murray.

332. Ocean Engineering (3) spring
Quantitative oceanographic information for engineers, with emphasis on the coastal zone. Navigation and energy systems; materials; pollution problems; brief survey of the offshore petroleum and mining industries; manned and telechiric undersea operations. Prerequisite: consent of department chairman. Mr. Richards.

333. Ocean Engineering Field Investigations (1-3) summer
Field studies in ocean engineering involving participation in research investigations conducted at sea. Prerequisite: consent of department chairman. Messrs. Richards and Hirst.

341. Soil Stabilization (3) spring
The mechanisms of soil stabilization: compaction, use of additives (aggregates, cement, asphalt, chemicals), special techniques. Principles and techniques of soil stabilization for use as foundation material in highways and airfields; theories of flexible and rigid pavement design. Prerequisite: CE 143 or equivalent. Mr. Hirst.

342. Experimental Soil Mechanics (3) fall
Experimental studies dealing with the measurement of soil properties in the laboratory and in situ; application of these properties to design; consolidation; strength of soils in triaxial compression and other shear tests, including measurement of pore water pressures; model design and analysis; field measurement of in situ soil properties; laboratory and field instrumentation. Prerequisite: CE 143 and senior standing. Messrs. Hirst and Fang.

343. Seepage and Earth Structures (3) spring
Long- and short-term stability of embankments and cut slopes; numerical and graphical methods of stability analysis; seepage through soils; design of earth dams, embankments and excavations; influence of seepage on embankment stability; construction control and field measurement of pore pressures and earth movements. Prerequisite: CE 143 or equivalent. Mr. Fang.

352. Structural Dynamics (3)
Analysis of linear structural systems to time-dependent loads. Free and forced vibration. Classical and numerical methods of solution. Lumped-mass techniques, energy methods, and introduction to matrix formulation of dynamic problems. Application to design. Prerequisite: Math 205, CE 259 or equivalent. Mr. Yen.

359. Plastic Analysis and Design (3) spring
Plastic analysis and design of steel structures. Strength and behavior of frames and component parts beyond the elastic limit. Methods of predicting strength and deformation in the plastic range. Studies of industrial and multistory frames. Comparison of plastic design techniques with allowable-stress design methods. Current research. Prerequisite: CE 259 or equivalent.

360. Advanced Structural Design (3) spring
Project-oriented advanced design of structures for bridges and buildings in steel or reinforced concrete and combinations of both materials. Emphasis on economy, strength and performance. Consideration of design of timber or glued-laminated structures, depending on student interest. Prerequisites: CE 261 and CE 263 or equivalent.

365. Prestressed Concrete (3) spring
Principles of prestressing. Analysis and design of basic flexural members. Instantaneous and time-dependent properties of materials. Prestress losses. Additional topics may include continuity, partial prestressing, compression members, circular prestressing, etc. Prerequisites: CE 263; CE 259 previously or concurrently, or consent of chairman. Mr. Huang.

371. Environmental Health Engineering (3) spring
Engineering applications to public health; food and milk sanitation, solid wastes, vector control, communicable disease control. Institutional and industrial sanitation, housing, air pollution, bathing and recreational water quality. Prerequisite: senior standing. Mr. Johnson.

374. Sanitary Engineering Analysis and Operations (3) fall
Applications of chemical theory, concepts of operations commonly used in water quality control and laboratory evaluations for design of processes in water and waste-water treatment. Prerequisite: CE 271 or consent of department chairman. Mr. Usinowicz.

376. Water Resources Engineering (3) fall
Utilization of principles of hydraulics, hydrology and environmental engineering in problems of erosion and flood control, power, irrigation, navigation, and water quality control; economics and water law in river basin planning. Prerequisites: CE 222 and CE 170 or consent of department chairman. Mr. Johnson.

380. Design Projects (1-6) fall-spring
Design project work as a member of a team, probably including students from differing disciplines. The project will attack a problem which, when possible, relates to a problem of one of the local communities or industries. Specific projects will normally be guided by faculty from several departments with consultants from off-campus. May be repeated for credit. Prerequisite: consent of department chairman.

381. Special Topics (1-3)
A study of selected topics in civil engineering, not included in other formal courses.

385. Research Procedures Seminar (1) spring
Planning and execution of research projects, survey of current research, elements of proposals and budgets. Literature search procedures. Presentation of data, and of written and oral reports. Guidelines for visual aids. Mr. Beedle.

Graduates programs

Graduate studies in civil engineering permit the student to build upon the broad background of undergraduate education in order to prepare for professional practice at an advanced level, for research and development, or for teaching.

The selection of graduate courses and research opportunities offered in the department permits the development of study programs either encompassing a wide range of interests or pursuing a special area of civil engineering in depth. The department offers advanced work in structural engineering, geotechnical engineering, geotechnical ocean-engineering, hydraulic engineering and environmental engineering, leading to the master of science, master of engineering and doctor of philosophy degrees.

A graduate program leading to the master of science degree normally consists of a number of courses in a major area, plus at least two courses in a minor area or areas. Each candidate for the M.S. degree is required to submit a thesis representing three to six credits (CE 491), or alternately, a report based on a research course of at least three credits (CE 429, 439, 449, 469, 479 or 481); however, a minimum of 24 credits in the program should consist of courses outside this group.

A graduate program leading to the master of engineering degree stresses engineering applications and design. The courses may extend across the various specialty areas in civil engineering. Each candidate for the M.E. degree will be required to complete an engineering project representing three to six credits (CE 460) in place of the thesis or research report required for the master of science degree.

A number of selected subjects offered by the departments of mechanical engineering and mechanics, chemical engineering, metallury and materials science, biology, and geological sciences also may be considered a part of the major field in civil engineering. A list of such subjects is available through the department chairman.

The Ph.D. degree program normally includes courses in the major field; courses in minor fields; and a dissertation presenting results of original research. In addition, each candidate is required to have some education in one or two nonengineering fields. This requirement may be met by taking two courses (200-level or above), or by taking two foreign language courses, or by passing a language proficiency examination. Holders of master's degrees planning to become candidates for a Ph.D. take a qualifying examination at the first opportunity following one semester in residence. After qualification, the program of work is formulated by the candidate, his or her special committee, and the department chairman.

The laboratories of the department are located in the Fritz Engineering Laboratory. Established in 1909 by the generosity of the late John Fritz, and improved through additions to apparatus and equipment, the laboratory offers complete facilities for research and instruction in structural engineering, geotechnical engineering, model analysis, fluid mechanics and hydraulics, environmental engineering, and other related fields.

Structural testing equipment includes dynamic testing machines, a 5,000,000-pound universal hydraulic testing machine, and other special loading apparatus. Hydraulic testing equipment includes a dredge pump test facility, plus installations for testing models of spillways, open channels, and beach facilities. A brochure describing the research facilities and programs is available on request.

An interdisciplinary relationship with the Center for Marine and Environmental Studies enables the development of academic and research programs in ocean engineering.

A number of research assistantships and teaching assistantships are available to provide financial aid to students of outstanding promise. The half-time research or teaching duties required of holders of assistantships provide valuable training which supplements the formal course offering. The graduate course offering of the department is programmed to fit the schedule of half-time assistants. A very limited number of scholarships and fellowships are available to provide financial aid for full-time study.

Fig. 915 — EGYPTIAN GIRL.

Graduate courses

403. Analytical Methods in Civil Engineering (3) fall
Analytical and numerical methods used in various fields of civil engineering. Matrix algebra in engineering analysis. Iterative, differencing, and discretization techniques. Energy principles and special methods. Treatment of typical differential equations in civil engineering. Introduction to theory of elasticity with some engineering applications. Prerequisite: Math 205 or equivalent. Mr. Ostapenko.

408. Computer Methods in Civil Engineering (3)
Numerical and computer-oriented methods specially applicable to the solution of complex problems arising in various fields of civil engineering. Solutions of well- and ill-conditioned linear and non-linear systems. Eigenvalue formulation of stability and dynamic problems. Reduction techniques, applied linear graph theory, integration schemes for large structural systems. Optimal design by linear programming. Introduction to problem-oriented languages and computerized design. Prerequisites: CE 403 or equivalent, and working knowledge of Fortran IV programming. Mr. Kostem.

409. Finite Element Method in Structural Mechanics (3) spring
Basic principles and equations governing the finite element method. Analysis of planar, axisymmetric, plate and articulated structures, with emphasis on analytical modeling. Accuracy and convergence studies, utilizing different discretizations and various types of elements. Case studies include application and extension to material nonlinearities, bridges, containment vessels, and soil-structure interaction. Prerequisites: CE 403, CE 450, or equivalents; working knowledge of Fortran. Mr. Kostem.

424. Surface Water Hydrology (3) spring
The study of quantities in the flow of water in streams. Hydrographs. Application of statistical analysis and probability to hydrological problems. Drainage basin analysis. Prerequisite: CE 325 or equivalent.

425. Hydraulics of Sediment Transport (3)
Hydrodynamic forces on particles, settling velocity. Sediment transport in open channel: tractive force theory, bed load and suspension

theory, total load and wash load. Bedform mechanics, cohesive channel hydraulics. Sediment transport in closed conduits. Shore processes and coastline hydraulics. Prerequisites: CE 121 and CE 222, and consent of department chairman.

428. Advanced Topics in Hydraulics (1-3)
Recent developments in hydromechanics and hydraulics. Topics to be selected from: wave mechanics, theory of flow through porous media, dispersion, hydrodynamic forces on structures, potential flow, free streamline theory, open channel hydraulics, computer methods. Prerequisites: CE 322 and consent of chairman. May be repeated for credit.

429. Hydraulic Research (1-6)
Individual research problems with reports. May be repeated for credit.

431. Geotechnical Ocean Engineering (3)
Study of the engineering and scientific aspects of soils flooring the oceans; soils and their distribution; theory and practice of sampling, laboratory and in situ testing, geophysical methods, and computerized data synthesis; biological, geochemical, and physical properties of the electrolyte-gas-solid soil system of the sea floor and the response of this system to applied static and dynamic forces. Prerequisite: CE 143 or equivalent. Messrs. Richards and Hirst.

437. Advanced Topics in Geotechnical Ocean Engineering (1-3)
Advanced study of selected topics in geotechnical ocean engineering, such as: physico-chemistry of ocean sediments; foundation design in soft sediments; instrumentation for deep-sea soil surveys; and others. Selection of topics will depend on particular qualifications of the staff, as well as interest of students. Prerequisite: consent of department chairman. May be repeated for credit.

439. Ocean Engineering Research (1-6)
Individual research problems with reports. May be repeated for credit.

443. Advanced Soil Mechanics I (3) fall
The origin, composition, and physico-chemical properties of soils and their influence on the engineering properties and behavior of soils; transmission of water in saturated and unsaturated soils; advanced theory of compaction; compression and consolidation; theories of shear strength. Prerequisite: a course in soil mechanics. Mr. Hirst.

444. Advanced Soil Mechanics II (3) spring
Fundamental and advanced theories of soil mechanics applicable to earth structures and foundation design; stresses in homogeneous and layered systems for ideal elastic, plastic and visco-elastic soils; lateral earth pressures; slope stability; vibration and other dynamic forces. Prerequisite: CE 443. Messrs. Fang and Hirst.

445. Advanced Foundation Engineering (3) fall
Current theory and practice relating to the design of foundations for buildings and other structures. Analysis and limitation of settlements; bearing capacity analyses of shallow foundations and piles; flexible and rigid retaining wall design; embankment design; control of seepage and other construction problems; site investigations. Prerequisite: a course in soil mechanics. Mr. Fang.

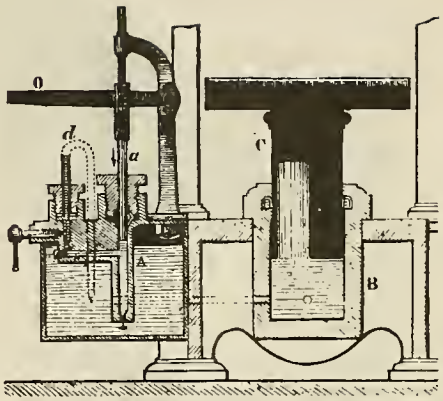

Fig. 1345. — HYDROSTATIC PRESS.

447. Advanced Topics in Geotechnical Engineering (1-3)
Advanced studies in selected subjects related to geotechnical engineering. The general areas in which studies may be taken include: stress-strain-time relationships of soils, colloidal phenomena in soils, ground water flow and seepage, soil dynamics, soil plasticity, numerical methods applied to soil mechanics, earth dam design, theories of layered systems and their application to pavement design, rock mechanics. The studies specifically undertaken in any particular semester depend on the availability of staff and the interest of students. Prerequisite: consent of department chairman. May be repeated for credit.

449. Geotechnical Research (1-6)
Individual research problems relating to soil engineering, with report. Prerequisite: a course in soil mechanics.

450. Advanced Structural Theory I (3) fall
Statical and geometrical stability and degree of statical indeterminacy. Application of energy methods such as virtual work, minimum total potential, minimum complementary energy, and Castigliano's theorems. Introduction to force and displacement matrix analysis of structures. Messrs. Daniels and Driscoll.

451. Advanced Structural Theory II (3) spring
Specialized methods of analysis: column analogy, moment distribution. General treatment of deformation methods using matrix algebra. Selected topics in structural theory: influence lines, multi-story building frames, space structures. Introduction to finite element method; non-linear problems. Prerequisite: CE 450. Mr. Driscoll.

453. Structural Members and Frames (3) fall
General torsion of thin-walled open, closed, and combined open and closed cross-sections; general instability of thin-walled members; inelastic instability; special problems in stability. Desirable preparation: Mech 415. Prerequisites: CE 403 and consent of department chairman. Mr. Lu.

454. Plate and Shell Structures (3)
Plates and slabs loaded transversely and in their plane. Buckling and postbuckling behavior of elastic and inelastic plates. Membrane and bending analysis of cylindrical, rotational, and hyperbolic-paraboloidal shells. Emphasis on engineering methods. Design considerations. Prerequisites: CE 403, consent of department chairman. Mr. Ostapenko.

455. Advanced Structural Dynamics (3)
Analysis and design of structures to resist wind, earthquake, and blast loading. Matrix methods and computer applications. Non-linear and elasto-plastic response. Damping characteristics of structures and structural components, spectral analysis, dynamic instability. Characteristics of aerodynamic and seismic forces and nuclear blast. Introduction to vibration of three-dimensional structural systems. Prerequisites: CE 403, CE 352 or Mech 406, and CE 450 or equivalent.

457. Theory and Design of Steel Structures (3) spring
Analysis and design of steel structures; structural connections; composite steel-concrete systems and other components. Consideration

of residual stress; brittle fracture; fatigue strength; fastener systems. Study of current research and application to design practice. Mr. Fisher.

459. Advanced Topics in Plastic Theory (3) fall
Fundamentals of the mathematical theory of plasticity; the general theorems of limit analysis and their applications to beams under combined loading, arches, space frames, plates and shells. Limit analysis of two- and three-dimensional problems in soil, concrete, rock, and metal. Current developments. Prerequisite: CE 359. Mr. Chen.

460. Civil Engineering Project (1-6)
An intensive study of one or more areas of civil engineering, with emphasis on engineering design and applications. A written report is required. May be repeated for credit.

462. Experimental Methods of Structural Analysis (3)
Mechanical properties of structural materials and different procedures of evaluating these properties; experimental methods of stress analysis; statistical analysis of experimental data.

463. Experimental Methods of Structural Research (3)
Mechanical properties of structural materials and different procedures of evaluating these properties; experimental methods of stress analysis; statistical analysis of experimental data.

464. (Mech 416) Analysis of Plates and Shells (3) fall 1977, spring 1979
Bending of rectangular and circular plates, plates under lateral loads, plates with thermal and inelastic strains, effect of in-plane forces, large deflections, buckling of plates. Geometry and governing equations of shells, shells of revolution, membrane states, edge solutions, solution by numerical integration, non-symmetric problems, buckling of shells, applications to pressure vessels. Prerequisites: Math 205; Mech 305, or equivalent course in advanced mechanics of materials. Messrs. Kalnins and Updike.

465. Advanced Topics in Concrete Structures (3) fall
Advanced topics in reinforced and prestressed concrete. Limit design concepts. Yield line theory for concrete slabs. Composite members. Additional topics may include design of concrete bridge systems, shear walls, arches; seismic design. Prerequisite: CE 263 or equivalent. Mr. Huang.

466. Concrete Shell Structures (3)
Analysis and design of concrete shell structures. Folded plates, cylindrical shells, and shells of double curvature. Typical practical problems. Prerequisites: CE 403 and consent of department chairman. Mr. Ostapenko.

467. Advanced Topics in Structural Engineering (1-3)
Advanced study of selected topics in structural mechanics and engineering, such as: finite element methods, suspension systems; space frames; stability of non-linear systems; cold-formed and lightweight construction; optimization and reliability; second-order phenomena in structures; interaction of structures with environment; structural use of plastics; composite construction, etc. Selection of topics will depend on particular qualifications of the staff, as well as on the interests of the students. Prerequisite: consent of department chairman. May be repeated for credit.

468. (Mech 415) Stability of Elastic Structures (3)
Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilever column. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Buckling by torsion and flexure. Variational methods. Buckling of frames. Instability problems of thin plates and shells. Prerequisite: Math 205. Mr. Kalnins.

469. Structural Research (1-6)
Individual research problems with reports. May be repeated for credit.

471. Water Treatment Facilities (3) fall
Theory and design of water treatment facility components, from source to distribution system. Laboratory work in water chemical parameter determinations for design applications. Prerequisite: CE 374. Mr. Johnson.

472. Water Pollution Control Facilities (3) spring
Fundamental principles and design of water pollution control facilities for domestic and industrial waste waters. Physical-chemical and biological studies in laboratory determination of design parameters to be applied in design procedures. Prerequisite: CE 374. Mr. Johnson.

475. Advanced Topics in Water Resources (1-3)
Advanced study of selected topics in areas such as: physicochemical methods of water quality control; biological systems for waste-water treatment; multiple use of water resources; and others. Selection of topics will depend on particular qualifications of the faculty as well as interest of the students. Prerequisite: consent of department chairman. May be repeated for credit.

479. Environmental Engineering Research (1-6)
Individual research problems in environmental engineering with summary report. May be repeated for credit.

481. Special Problems (1-6)
An intensive study, with report, of a special field of civil engineering which is not covered in the other courses. A design project or an interdisciplinary study of a problem related to civil engineering may also be included. May be repeated for credit.

483. Graduate Seminar (1-3)
Study of current topics in civil engineering.

491. Thesis (1-6)

CLASSICS

Professors. Edna S. de Angeli, Ph.D., chairman; Douglas D. Feaver, Ph.D.

Assistant professor. Charles R. Phillips, III, Ph.D.

Majors in classics seek, through insight into the culture of ancient Greece and Rome, to gain an appreciation of Greco-Roman achievements in art, literature, philosophy and science, and to formulate an evaluation of the importance of these for modern culture.

Readings in the original languages of masterpieces, chosen both for their usefulness in developing skill in the languages and for their intrinsic worth and abiding importance, aim at developing an accumulative growth in the mastery of the languages and in the ability to interpret, criticize, and evaluate the achievements of classical civilization.

The basic work is supplemented by studies in the history, archaeology, art, philosophy, and literary history of Greece and Rome, and by an introduction to the basic tools and disciplines of scholarly research in this area. Students are encouraged to undertake research in fields of their own interest.

Classics as a major has stood the test of time, offering a general cultural background for careers in widely diverse fields in the professions, business and public service. It has particular relevance as a preparation for careers in teaching, law, writing, archaeology, and the church.

Lehigh University is a cooperating institution of the Intercollegiate Center for Classical Studies at Rome and of the American School of Classical Studies at Athens. Lehigh students are eligible for tuition grants at Athens and at Rome.

Major in Classical Greek

required preliminary courses

Greek 1, 2	Elementary Greek (6)
Greek 3, 4	Intermediate Greek (6)

required major courses

Greek 111, 112	Greek Drama (6)
Greek 113	Greek Historians (3)
Greek 203	Greek Epic (3)
Greek 271	Readings (3)
Greek 316	Plato (3)
Greek 21	Ancient History (3)
Greek 202	Archaeology of Greece (3)
Lat 51	Latin Literature in English Translation (3)

Majors in Greek write a translation examination during their seventh semester. No comprehensive examination is required.

Major in Latin

required preliminary courses

Latin 61	Elementary Latin (3)
Latin 62	Elementary Latin (3)
Latin 63	Intermediate Latin (3)
Latin 64	Intermediate Latin (3)

required major courses

Latin 165	Vergil (3)
Latin 166	The Latin Lyric (3)
Latin 168	Latin Drama (3)
Latin 22	Ancient History (3)
Latin 203	Archaeology of Italy (3)
Greek 50	Greek Literature in English Translation (3)

and nine hours from the following:

Latin 211	Readings (3)
Latin 212	Readings (3)
Latin 213	Ovid (3)
Latin 214	Medieval Latin (3)
Latin 303	The Roman Epic (3)
Latin 305	Satire (3)

Majors in Latin write a translation examination during their seventh semester. No comprehensive examination is required.

Major in Classics

This major is designed for those planning to go on to graduate work in classics, ancient history, ancient philosophy, classical archaeology, and classical linguistics.

Programs in this major are worked out for each student with due consideration for the individual's particular preparation and specific goals. In general the program requires as a minimum:

a. 18 hours of courses in either the Latin or Greek language at the "100" level or higher.
b. 12 hours of courses in the second language.
c. six hours in ancient history (Greek 21, Latin 22).
d. six hours in Senior Seminars (Greek 381, Latin 382).

Depending upon specific goals the student will be strongly urged to take courses in fine arts, mediaeval history, philosophy, French and German.

Either a comprehensive examination or a senior essay will be required for graduation.

Major in Classical Civilization

required preliminary courses (9 credit hours)

One course in Latin or in Greek at the 100 level (3)

Greek 21	Ancient History (3)
Latin 22	Ancient History (3)

required major courses (24 hours in one of the areas of concentration)

concentration in archaeology

Greek 102	Ancient Art (3)
Greek 201	Archaeology of the Near East (3)
Greek 202	Archaeology of Greece (3)
Latin 203	Archaeology of Italy (3)
Latin 204	The Ancient City (3)
Social Relations 9	The Anthropological Enterprise (3)

one course chosen from the area of classical literature (3)
one course chosen from the following: Phil 131; Religion Studies 111, 112, 113 (3)

concentration in classical literature

Greek 50	Greek Literature in English Translation (3)
Latin 51	Latin Literature in English Translation (3)
Greek 102	Ancient Art (3)
Greek 250	Women in Antiquity (3)
Greek 251	Classical Mythology (3)
Greek 203 or Latin 303	Greek Epic (3) or The Roman Epic (3)

one approved course in English Literature or Modern Foreign Literature in Translation at the appropriate level. Advanced courses in Greek, Latin or modern foreign languages may be offered to meet this requirement, e.g.:

English 323	Shakespeare and the Elizabethan Drama (3)
English 331	Milton (3)
Drama 301	History of the Theatre (3)
French 321	French Literature in Translation (3)

one course chosen from the area of archaeology (3)
one course chosen from the following: Phil 131; Religion Studies 111, 112, or 113 (3)

A comprehensive examination or senior essay is required in the area of concentration.

Classical Greek

Undergraduate courses

1. Elementary Greek (3) UP fall
For all students who desire to obtain a knowledge of the fundamentals of the Greek language. Early in the semester there will be reading in stories and legends in easy Greek.

2. Elementary Greek (3) UP spring
Continued work in Greek vocabulary, forms and syntax. Selected readings in Greek prose. Prerequisite: Greek 1.

3. Intermediate Greek (3) UP fall
Xenophon: *Anabasis* or Herodotus, *Histories*. Grammar review. Prerequisites: Greek 1 and 2, or one year of entrance Greek.

4. Intermediate Greek (3)UP spring
Plato: *Euthyphro, Apology*, and *Crito*, or other dialogues. Prerequisite: Greek 3.

21. (Hist 21) Ancient History (3) UP fall
The development of civilization from palaeolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic and literary development of the ancient world; the origin of political institutions. Mr. Phillips.

50. Greek Literature in English Translation (3) UP fall
Readings in major genres of Greek literature; emphasis on development of epic, drama and lyric poetry. No knowledge of the Greek language is required. Mrs. de Angeli.

102. (Fine Arts 102) Ancient Art (3) UP spring
A history of the visual arts in the ancient world from prehistoric to the period of Constantine the Great. Correlation with political, social, and literary background of each culture.

111. Greek Drama (3) fall, alternate years
Representative plays of Sophocles, Euripides and Aristophanes, Literary study of the drama. Prerequisite: Greek 4.

112. Greek Drama (3) spring, alternate years
Continuation of Greek 111. Prerequisite: Gk 4.

113. Greek Historians (3) fall, alternate years
Selections from Herodotus, Thucydides or Xenophon. A study of Greek historiography. Prerequisite: Greek 4.

For advanced undergraduates and graduates

201. Archaeology of the Near East (3) UP fall, alternate years
Aims and methods of archaeology. A chronological survey of archaeological finds from Palaeolithic, Neolithic, Bronze Age, Iron Age and later cultures in the Near East, concentrating on the Nile, Tigris-Euphrates River basins, and the Levant. Material illustrating the cultures and events of the Bible. Mr. Feaver.

202. Greek Archaeology (3) UP fall, alternate years
Aims and methods. A chronological presentation of prehistoric civilizations including the Neolithic, Minoan, Helladic and Mycenaean periods. A study of extant ancient monuments, buildings, and city plans of important sites of the classical and Hellenistic periods. Lectures, collateral readings and reports. Mr. Feaver.

203. Greek Epic (3)
Reading of considerable portions of the Homeric Epics and a study of the poems as works of literature. Studies of the background of the poems, and introduction to scholarly problems of interpretation and theories of origins. Prerequisites: six hours of courses at the 100 level and consent of department chairman.

250. Women in Antiquity (3) UP spring
Status of women in antiquity in light of modern thinking about women's roles in society. Literary and archaeological evidence for the battle of the sexes in ancient Greece and Rome. Offered alternate years. Mr. Phillips.

251. Classical Mythology (3)
Readings in the major myths and legends of ancient Greece and Rome, with intensive study of those having the greatest relevance for modern man. The changing aspects of myth as reflected in both ancient and modern literature. Consideration of the transmission of myth in nonliterary aspects of our culture. Mrs. de Angeli.

271. Readings (3) spring, alternate years
Intensive reading in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of department chairman.

316. Plato (3)
The Republic, and other dialogues. Lectures on classical philosophy. Prerequisites: six hours of courses at the 100 level and consent of department chairman.

381. Senior Seminar (3)
A proseminar: introduction to classical scholarship with particular attention to the methods of research, bibliographical aids, and scholarly literature. Surveys will be made of such varied fields as archaeology, numismatics, hermeneutics, palaeography, and epigraphy. Prerequisite: consent of department chairman.

Latin

22. (Hist 22) Ancient History (3) UP spring
Continuation of Greek 21. Rome from its origin to 395 A.D. Mr. Phillips.

51. Latin Literature in English Translation (3) UP spring
Readings in major genres of Latin literature. Emphasis on epic, Roman comedy and satire. No knowledge of the Latin language is required. Mrs. de Angeli.

61. Elementary Latin (3) UP fall
For all students who desire to obtain a knowledge of the fundamentals of the Latin language. Special emphasis on English derivations and the principles of grammar.

62. Elementary Latin (3) UP spring
Continuation of Latin 61. Prerequisite: Latin 61 or two entrance units.

63. Intermediate Latin (3) UP fall
Selections from the easier authors. Grammar review. Prerequisite: Latin 62 or three entrance units.

64. Intermediate Latin (3) UP spring
Selections from representative writers. Review of grammar and syntax. Prerequisite: Latin 63 or consent of department chairman.

165. Vergil (3) UP spring
Vergil: *Aeneid,* selections from the entire work; study of the aesthetic, political, and philosophical values of Vergil's poetry. Prerequisite: Latin 64 or consent of department chairman.

166. The Roman Lyric (3) fall
Selected poems of Horace and Catullus. Lectures on development of lyric poetry. Introduction to metrics. Prerequisite: Latin 65 or four entrance units. Mrs. de Angeli.

168. Latin Drama (3) spring
Readings of selected plays of Plautus, Terence and Seneca. Prerequisite: Latin 65 or at least four entrance units.

For advanced undergraduates and graduates

203. Archaeology of Italy (3) UP spring, alternate years.
Neolithic, Terramara, Villanovan and Etruscan cultures. Rome the city: its buildings, monuments, and streets, it destruction and rediscovery through excavation; origin and growth of the city; the three periods, empire, republic, and kingdom; methods of identifying and dating monuments. A survey of Pompeii, Herculaneum and Ostia. Lectures, readings and reports. Mr. Feaver.

204. The Ancient City (3) UP spring, alternate years
Ancient cities seen through concepts of human community and political theory as compared with archaeological findings; ancient theories of city and city planning; attitudes to life in the city; rise of urban civilization from Neolithic prototypes through the Near East, Egypt, Greece and Rome; insights applicable to current urban problems. Mr. Feaver.

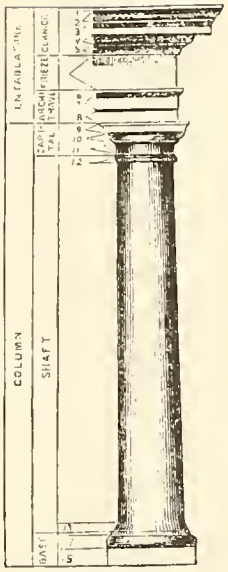

Fig. 650.
1, fillet; — 2, cyma recta; — 3, corona; — 4, ovules; — 5, cavetto; — 6, tenia; — 7, upper facia; — 8, lower facia; — 9, abacus; — 10, ovolo; — 11, neck; — 12, astragal; — 13, apophyges; — 14, torus; — 15, plintii.

211. Readings (3) fall
Intensive readings in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of department chairman.

212. Readings (3) spring
Intensive reading in one author or in a selected genre. Prerequisites: six hours of courses at the 100 level and consent of department chairman.

213. Ovid (3) fall
The *Metamorphoses* and major elegiac works. Development of courtly love. Prerequisites: six hours of courses at the 100 level or consent of department chairman.

214. Medieval Latin (3) spring
Selections from postclassical writers. Major genres of prose and poetry. Prerequisite: six hours of courses at the 100 level or consent of department chairman.

251. Private Life in Antiquity (3) fall
Spectacles and entertainment, morality and religion, problems of work and leisure, the military, social and intellectual problems.

303. The Roman Epic (3)
The epic in Latin literature with lectures on the Greek models; early Latin translations of Greek epics: later minor writers of epic. Passages from Lucretius, Vergil and Ovid; a study of the *Aeneid* in its entirety. Prerequisites: six hours of courses at the 100 level and consent of department chairman.

305. Satire (3)
Selected satires of Horace and Juvenal. Lectures on the history of Roman satire and its influence on modern literature; study of social conditions under the empire. Prerequisites: six hours of courses at 100 level and consent of department chairman.

382. Senior Seminar (3)
Continuation of Greek 381. Prerequisite: consent of department chairman.

ECONOMICS

Professors. Finn B. Jensen, Ph.D., MacFarlane professor and chairman; J. Richard Aronson, Ph.D.; Nicholas W. Balabkins, Ph.D.; Alvin Cohen, Ph.D.; Gerald Garb, Ph.D.; Eli Schwartz, Ph.D.; L. Reed Tripp, Ph.D., Magee professor.

Associate professors. Jon T. Innes, Ph.D.; John D. Keefe, M.A.; John R. McNamara, Ph.D.; R. Charles Moyer, Ph.D.; Warren A. Pillsbury, Ph.D.; Ching Sheng Shen, Ph.D.; Robert J. Thornton, Ph.D.; John E. Walker, Ph.D.

Assistant professors. Bruce R. Dalgaard, Ph.D.; John L. Hilley, Ph.D.; Arthur E. King, Ph.D.; R. Allen Moran, Ph.D.

Instructor. James C. Luizer, M.A.

Major in Arts and Science

Note: Economics 1 is a prerequisite for all courses in economics.

Fig. 1104. — GALLEON.

required preliminary courses for the bachelor of arts degree

freshman year

Eco 1	Economics (4)
Math 41 and 44	BMSS Calculus (6)

required major courses

sophomore year

Eco 45	Statistical Method (3)

junior year

Eco 105	Microeconomic Analysis (3)
Eco 119	Macroeconomic Analysis (3)
Eco 229	Money and Banking (3)
Eco or Fin	Any 300-level course (6)

senior year

Eco or Fin	Any 300-level course (6)

Major in College of Business and Economics

Economics Major

Required: 15 credits of economics beyond the core listed on page 37.

Undergraduate courses

1. Economics (4) fall-spring
A course in the principles of economics. General topics covered are: the determination of national income; the determination of relative prices; money and banking; monetary and fiscal policy; and government finance.

All of the following courses in economics have as a prerequisite Economics 1 or equivalent.

45. Statistical Method (3) fall-spring
Descriptive statistics, elementary probability and probability distributions, sampling, estimation of population parameters, decision theory, regression and correlation, analysis of variance, nonparametric tests, time series analysis, and index numbers. Prerequisites: Math 41 or equivalent.

105. Microeconomic Analysis (3) fall-spring
Determination of prices in terms of the equilibrium of the business enterprise and consumer choices in markets of varying degrees of competition; determination of wages, rent, interest, and profits.

119. Macroeconomic Analysis (3) fall-spring
An introduction to macroeconomic measurement, theory, and policy. Provides framework within which broad macroeconomic policy prescription can be formulated especially with reference to such problems as inflation and unemployment.

For advanced undergraduates and graduates

229. Money and Banking (3) fall-spring
A general course dealing with the nature and functions of money and commerical banking, monetary and banking development in the United States, the value of money, and monetary, credit and fiscal policies.

300. Apprentice Teaching in Economics (1-3)

303. Economic Development (3) fall
The principal determinants of economic development; economic development in advanced and underdeveloped countries. Mr. Cohen.

305. The Economic Development of Latin America (3) spring
Forces at work in the changing economics in Latin America: in addition to the economic variables, social and political factors are considered and related to technological change and the development process. Mr. Cohen

309. Comparative Economic Systems (3) fall
A comprehensive examination of the philosophical, economic, and political tenets of American capitalism, Soviet socialism, and Nazi fascism. Analysis of economic planning under various socio-economic systems: study of comparable economic growth of the United States and the Soviet Union. Mr. Balabkins.

310. Economic Evolution (3) spring 1977 and every other year
Long-term economic growth and social transformation of the United States. Messrs. Balabkins and Thornton.

311. Environmental Economics (3) fall-spring
Economic policies for environmental protection. The optimal development of natural resources. The relationship between economic growth and environmental degradation. Case studies in water-quality management. Mr. McNamara.

312. Urban Economics (3) spring
A survey and analysis of economic problems related to urban areas; the nature and function of cities; the economic and spatial characteristics of urban activity including housing, land value, land use, transportation, fiscal problems, urban labor markets and poverty. Mr. Pillsbury.

313. History of Economic Thought (3) fall, even-numbered years
Chronological survey and critical evaluation of the evolution of economic science. Analysis of the contributions of the Classical, Marginalist, Neo-classical, Keynesian, Institutionalist, and Structuralist schools. Mr. Cohen.

320. Advanced Macroeconomic Analysis (3) spring, even-numbered years
A further course in macroeconomic theory and policy. Primary consideration is given to alternative theoretical specifications of complete monetary economies and the resulting policy implications for achieving economic growth and stability. Prerequisite: Eco 119 or equivalent. Mr. Innes.

332. Monetary-Fiscal Policy (3) spring
A course devoted to the study of monetary, credit and fiscal policies of governments and central banks with particular reference to the policies of the United States Treasury and the Federal Reserve system. Current problems will receive special emphasis. Prerequisite: Eco 119 or equivalent. Mr. Dalgaard.

333. Managerial Economics (3) fall-spring
The fundamental business disciplines are integrated through the development of a model of managerial decision-making. Emphasis on the application of economic theory to a variety of

business problems. Consideration is given to problems involving risk and uncertainty. Case studies are employed as illustrative examples.

335. Labor Economics (3) fall-spring
The structure of the labor force; the theory of wages and employment; the economics of legal and social aspects of the labor market. Messrs. Tripp and Thornton.

336. Business and Government (3) fall, odd-numbered years
Microeconomic theory and the American legal system. Efforts by the state to maintain, moderate, and supersede competitive private contracting as a social arrangement by which to promote risk-taking, efficiency, equitable exchange, progressiveness, conservation, and individual liberty. Economic analysis of results. Mr. Pillsbury.

337. Transportation and Spatial Economics (3) spring, even-numbered years
The principles of transportation in theory and practice are integrated with traditional and spatial economics. Transport models and location theories are reviewed for varying conditions of spatial separation of economic activity. Transportation policies are analyzed and evaluated in terms of their efficiency in the allocation of resources for the firm and the economy at the local, regional and national levels. Prerequisite: Eco 105 or consent of department chairman. Mr. Pillsbury.

338. Labor Market Insitutions (3) fall
The development of the social and legal status of trade unions; the process of collective bargaining; the evolution of modern social welfare programs. Messrs. Tripp and Thornton.

339. International Trade (3) fall
The theory of international trade; the theory of tariffs; United States commercial policies; the impact of growth and development on the world economy. Mr. Jensen.

340. (Fin. 340) International Finance (3) spring
The balance of payments and the theory of disturbances and adjustment in the international economy; international monetary policies. Prerequisite: Eco 229. Messrs. Jensen, and Hilley.

343. European Economic Integration (3) spring, odd-numbered years
Analysis of the problems of economic integration with special emphasis on the development of economic cooperation and integration in Western Europe. The methods and the problems of economic planning in the Common Market. United States trade and investments and European economic integration. Mr. Jensen.

346. Business Cycles and Forecasting (3) fall, odd-numbered years
A study of economic conditions, involving short-term fluctuations, growth, forecasting and stabilization proposals. Prerequisite: a course in statistics. Mr. Moran.

348. Advanced Business Cycles (3)
Recent business cycle theories; the evolution of the theories and the problems of economic change which the theories attempt to explain. Prerequisite: Eco 346. Students desiring this course should consult the department chairman.

351. Introduction to Mathematical Economics (3) fall, even-numbered years.
Applies mathematical techniques to economic problems of optimization and constrained optimization and to economic models involving both comparative static and dynamic analysis. Prerequisites: Math 41 and 49, Eco 105 and 119. Mr. Innes.

352. Advanced Statistical Methods (3) spring
A further course in quantitative method: sampling design, probability distributions including the analysis of variance, and multiple correlation and their application to common situations. Prerequisite: Eco 45 or equivalent. Mr. Shen.

353. (Fin 353) Public Finance: Federal (3) fall
A course dealing with government expenditures and revenues, the economics of taxation, and government administration. Mr. Aronson.

354. (Fin 354) Public Finance: State and Local (3) spring, odd-numbered years
The major issues regarding revenues, expenditures, debit and budgeting policy are examined in the light of fiscal principles and economic effects. Particular attention is given to current practices in Pennsylvania and contiguous states. Prerequisite: Eco 353. Mr. Aronson.

355. Empirical Economic Analysis (3)
The course provides empirical content to the theoretical concepts developed in intermediate economic theory (micro- and macro-). Prerequisites: Eco 45, 105 and 119. Students desiring this course should consult the department chairman. Mr. Innes.

371. Readings in Economics (3)
Readings in various fields of economics, designed for the student who has a special interest in some field of economics not covered by the regularly rostered courses. Prerequisite: preparation in economics acceptable to the department chairman.

372. Readings in Economics (3)
Continuation of Eco 371.

For graduates

The course descriptions for Eco 405, 417 and 429 appear on page 218.

404. Development Theory and Problems (3) fall, even-numbered years
The evolution of growth doctrines and the analysis of such developmental problems as: structural versus monetary reform, ideological controversy of the appropriate economic system, balanced investment programs as opposed to unbalanced plans, the nature and changes in the aggregate production function, and dependence upon domestic as opposed to foreign sources of savings. Prerequisite: Eco 303. Mr. Cohen.

407. History of Economic Thought (3) spring, odd-numbered years
Consideration of selected topics in the history of economic thought, with special attention devoted to tracing the origins of modern economic theory. Prerequisite: graduate exposure to economic theory. Mr. Cohen.

411. Economics of Environmental Management (3) fall, even-numbered years
The economic theory of natural resources. Optimal policies for the development of renewable and nonrenewable resources. Pollution, congestion and common property problems. Environmental quality management systems. Prerequisites: Eco 105 or equivalent and Math 44 or equivalent. Mr. McNamara.

415. (Fin 415) Capital and Interest Theory (3) fall
Examination of theories of interest and capital. The following topics are investigated: present value theory; investment valuation under certainty and risk; term structure of interest rates; the theory of savings, cost of capital, and capital formation. Prerequisite: consent of department chairman. Mr. Schwartz.

425. Public Finance (3) spring, even-numbered years
Major issues in taxation of income consumption, and capital; principles of government debt management; budgeting and fiscal planning for economic stability and growth. Mr. Aronson.

431. Managerial Economics (3) fall-spring
Problems of business enterprise: price and output determination analysis of cost and demand functions in markets of various types and under various conditions of general business. Emphasis will be on the application of economic theory to business practice. Prerequisite: Eco 105 or consent of the department chairman. Mr. McNamara.

432. Advanced Microeconomic Analysis (3) fall
A survey of methods of decision-making at the microeconomic level utilizing concepts developed in price theory and econometrics. Prerequisite: Eco 105 or equivalent. Mr. Garb.

435. Advanced Topics in Microeconomics (3) spring, odd-numbered years
Topics in resource allocation and price determination. Theories of choice of consumers, firms, and resource owners under monopoly, monopsony, competition, and alternative market forms. Prerequisites: Eco 432 or equivalent and consent of department chairman. Mr. Garb.

436. Advanced Topics in Macroeconomics (3) spring, odd-numbered years
Theory of employment, income, and growth. Role of money in theory of output. Policies for economic stability and growth. Prerequisite: consent of department chairman. Mr. Innes.

437. Labor Economics (3) fall
The economic environment of labor and industrial relations with some emphasis on current research involving theoretical and empirical analyses of labor markets. Prerequisite: Eco 335 or 338 or equivalent. Messrs. Tripp and Thornton.

438. Labor-Management Administration (3) spring
A study of the administration of the relationship between management and the labor force both where that relationship is governed by a formal agreement and where it is not. The concepts underlying the substantive provisions of labor agreements are analyzed. The problem of agreement-making and the methods for peacekeeping are subjected to critical appraisal. Prerequisite: Eco 335 or 338 or equivalent. Mr. Tripp.

440. Regional Science-Metropolitan Analysis (3) fall, even-number years
A study of the methodology of regional science with emphasis on metropolitan area analysis. A survey of the applications of this methodology to the economic problems of regions and metropolitan areas. Mr. Pillsbury.

442. (Fin 442) Foreign Trade Management (3) spring, odd-numbered years
Current problems of foreign operations, including channels of export in foreign markets, export and import financing, foreign investments, policies of government and international agencies as they affect foreign operations. Mr. Jensen.

444. (Fin 444) Banking and Monetary Policy (3) fall-spring
Description and analysis of the U.S. monetary and banking structure. The supply and demand for funds. Financial markets. Central bank controls; monetary theory and policy. Prerequisite: a course in money and banking. Messrs. Aronson, Innes and Schwartz.

445. International Economic Theory (3)
The theory of international economics, with emphasis on the way in which general economic theory is applied to the problems and issues of international economics. Prerequisite: consent of the department chairman. Students desiring this course should consult the chairman. Mr. Garb.

453. Index Numbers and Time Series Analysis (3)
Theory and construction of Index Numbers. Measurement and analysis of irregular, seasonal, cyclical and secular components. Exponential smoothing, distributed lags, and introduction to spectral analysis. Students desiring this course should consult the department chairman. Mr. Shen.

454. Forecasting (3) spring, even-numbered years
A study of the methods of business forecasting and its relation to planning with emphasis on the prediction of growth and short-term movements. Prerequisite: Eco 346 or equivalent. Mr. Shen.

455. Econometric Methods (3) spring, odd-numbered years
Mathematical and statistical specification of economic models. Statistical estimation and test of economic parameters in single and multiple equation models. Prediction and test of structural changes. Prerequisites: background in statistics and calculus. Mr. Shen.

456. Mathematical Economics (3) fall, odd-numbered years.
Designed to provide an understanding of the way in which various mathematical techniques are applied in the formulation and development of economic concepts and theories. The course may draw on theories of the consumer and of the firm, the analysis of economic fluctuations and growth, general equilibrium theory, and other areas of economics where mathematical techniques have been found to be useful. Prerequisite: consent of department chairman. Mr. Garb.

461. Methodology in Theory and Research
Foundations of theory construction and empirical research in economics and related subject matter. Theory, hypothesis formation and empirical study in the business firm, organizations, industrial relations, and micro-macro research. Students desiring this course should consult the department chairman. Mr. Garb.

471. Special Topics (3)
An extended study of an approved topic in the field of economics.

472. Special Topics (3)
Selected topics not covered in scheduled courses in the department. May be repeated for credit with the consent of the department chairman.

490. Thesis in Economics (6)
Subjects for these may be selected by consultation with the major adviser and approval of the department chairman and master of arts committee.

EDUCATION

Professors. Robert D. Stout, D.Sc., acting dean; Perry A. Zirkel, J.D., Ph.D., dean effective June 1, 1977; John A. Stoops, Ed.D., distinguished professor of educational philosophy; Alfred J. Castaldi, Ed.D.; Andrew J. Edmiston, Ph.D.; Charles W. Guditus, Ed.D.; John A. Mierzwa, Ed.D.; Paul VanR. Miller, Ph.D.; Norman H. Sam, Ed.D.

Associate professors. Raymond Bell, Ed.D.; Matthew W. Gaffney, Ed.D.; Margaret C. Grandovic, Ed.D.; Jerome T. Kapes, Ph.D; Joseph P. Kender, Ed.D.; Robert L. Leight, Ed.D.; James G. Lutz, Ed.D.; Estoy Reddin, Ed.D.; Alice D. Rinehart, Ed.D.; William B. Stafford, Ed.D.; LeRoy J. Tuscher, Ph.D.; Elvin G. Warfel, Ed.D.

Assistant professors. John W. Delonas, Ph.D.; Warren R. Heydenberk, Ed.D.; John L. Manni, Ed.D.; Artis J. Palmo, Ed.D.; Stephen M. Stillman, Ph.D.; Harry T. Zechman, Jr., Ed.D.

Adjunct professor. William G. Bartholomew, Ed.D.

Instructors. Elizabeth Conard, M.Ed.; Thomas J. Laffey, M.S.S.; Thelma P. Lifland, M.Ed.; Anthony Noto, M.A.

Lecturers. Haru Lemke, M.Ed.; William W. Oswalt, Ed.D.; Henry W. Ray, Ed.D.; John C. Turoczi, Ed.D.

Centennial School teachers. Thomas Fleck, Ed.D., director; George Conner, B.A.; Edward Crawford, M.Ed.; Edward DelViscio, B.A.; James Garrigan, Ed.D.; Carol Hammett, B.S.; Deborah Husson, B.S.; Frances Jennings, B.A.; Joseph Kempfer, B.A.; Janeen Lee, B.A.; Steven McCulley, B.S.; Francis Minotto, M.S.; Susan Murray, B.S.; Barbara Nothstein, B.S.; Lloyd Parker, M.Ed.; Ruth Parr, M.Ed.; Helene Pierce, B.S.; Barbara Seiffert, M.S.; Karol Strelecki, M.S.; David Thomas, B.S.; Jane Todd, B.A.; Robert Torpey, B.S.; Roger Washburn, B.S.

Department of Administration and Supervision

For advanced undergraduates and graduates

381. Educational Systems and Information Processing (3) fall-spring
Introduction to the basic principles of systems analysis, information processing, cost analysis, and conversion systems. Emphasis to be placed upon the application of computers and data processing to administration and instruction in basic educational institutions. Mr. Tuscher.

383. Computer-Assisted Instruction (3)
The design and development of computer-assisted instructional units. Students design, program and test computer-assisted instructional units in one of several modes such as drill, practice, tutorial, simulation. Instructional units will be programmed in the Basic language. Prerequisite: consent of program director. Mr. Tuscher.

391-392. Workshop (1-3)
Cooperative study of current educational problems. Designed to provide elementary and secondary school teachers with an opportunity to work at their own teaching levels and in their own fields. Students are limited to six credits during a summer session but may register for more than one workshop provided there is no duplication in subject matter.

For graduates

403. Teaching in the Two-Year College (3)
Major theories of teaching, learning and measurement are studied with particular reference to the problems of instruction in the two-year college. The characteristics of students in two-year colleges are examined. Participants undertake research in the field. Mr. Guditus.

409. The Two-Year College (3)
Historical and philosophical analysis of the two-year college as an institutional mode in American higher education. The unique nature of the two-year college is considered in relation to its service functions and the values in American higher education. Participants undertake research in the field. Mr. Guditus.

426. Independent Study and Research (1-6)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated for credit.

443. Elementary School Administration (3)
The major problems of organization and administration of elementary schools; types of organization, pupil promotion, time allotment, service agencies, and plant and equipment. Required for a principal's certificate.

453. Secondary School Administration (3)
The major problems of organization and administration of secondary schools; program of studies, teaching staff, pupil personnel, plant and equipment, and community relationships. Required for a principal's certificate. Mr. Zechman.

454. The Secondary School Curriculum (3)
Methods of study of curriculum problems, selection of subject matter in various fields, principles of program construction, and similar problems. Mr. Zechman.

463. Public School Administration (3) fall-spring
A systematic treatment of the problems of administration, local, state and national. The

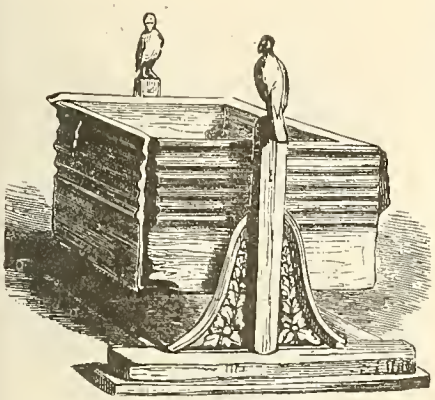

Fig. 709. — CRADLE OF HENRY V. (Tower of London.)

newer developments which are modifying educational administration; state authorization and organization, the board of education, the superintendent of schools, personnel management, business administration, financial support, and public relations. Mr. Guditus.

464. Foundations of Curriculum Construction (3) fall-spring
Principles of curriculum construction which underlie the reorganization of the program of studies for elementary and secondary schools; origin and background of the curriculum; methods of organization; curriculum planning and development; and pertinent applications. K-12.

465. Administration of Higher Education (3)
Analysis of legal foundations, administrative controls, and operational patterns of the various types of higher institutions with special emphasis on the two-year college. Coverage of traditions which establish duties, responsibilities, and rights of faculty, administration, and board of control in American colleges. Mr. Guditus.

466. Supervision of Instruction (3)
Analysis of the principles underlying the organization and supervision of instruction; application to specific teaching situations. No lines are drawn between the elementary and the secondary school. Mr. Guditus.

468. Administration of Student Service in Higher Education (3)
Study of the broad scope of the administration of student services in higher education including welfare functions, control functions, activities functions, and teaching functions. Emphasis to be placed upon matter of organization and operation, the place of these patterns in the total operation of the institution, and the administrator's role in the development and implementation of appropriate policies and practices affecting students.

473. Collective Bargaining in the Schools (3)
Contract negotiations, grievance, mediation, and arbitration for both professional and classified employees in education. Mr. Zechman.

474. Seminar in School Building (3)
The design, construction and modernization of educational facilities in terms of student, curricular, community and financial requirements. Mr. Gaffney.

475. Educational Resources Management (3)
Systems designed to support educational decision-making. Analysis of conceptual designs for planning-programming-budgeting and evaluation systems (PPBS). Mr. Tuscher.

476. School Finance (3)
Concepts of school finance including intergovernmental fiscal relations, state grants-in-aid, taxation, municipal borrowing, and long-term capital outlay programs. An examination of school business office operations is included. Mr. Gaffney.

477. Seminar in School-Community Relations (3)
Analysis and development of the communication and public relations skills needed by educators involved in dealing with the public. Mr. Gaffney.

478. Personnel Administration (3)
Overview of the personnel function in educational institutions. Emphasis upon emerging trends in staff planning, recruitment, selection, assignment, and orientation, as well as tenure, grievances and related matters. Mr. Zechman.

479. School Law (3)
The effect of school law upon the administration of public school systems, including analysis and synthesis of judical interpretations of the constitutions. statutes, rules, regulations, and common law relating to educational issues. Mr. Gaffney.

485. School Principals Clinic (3-6) spring
Simulated materials workshop on administrative decision-making open to practicing and prospective elementary and secondary school administrators. Mr. Tuscher.

491-492. Advanced Seminars in Education (3)

493. Research (3)
Basic principles of research and techniques of gathering and analyzing data. Exploration and comparison of various ways of bringing evidence to bear on the identification and solution of educational problems. Emphasis on critical reviews of research reports from various fields and representing various methodologies. A research report is required. Recommended to be taken before approval for master's candidacy.

494. Field Work (3-6)
Identification of significant problem(s) in an educational environment, review of the literature, and development of appropriate research plans. Three credits is the maximum permissible in a semester.

496. Seminar in Research (3)
For doctoral students. Research design and application to various kinds of educational problems; data collection and analysis. Seminar includes criticism and evaluation of student proposals and related research. May be repeated for a maximum of nine credits.

498. Internship (3-9)
Designed to give advanced students an opportunity to obtain practical experience. Conference hours for students and staff members will be devoted to discussion of work and problems encountered in the schools. Prerequisite: consent of program director.

Department of Human Development

For advanced undergraduates and graduates

330. Study of the Individual (3-6)
Examinations of individual growth and development, especially the patterns found in different subcultures. Prerequisite: consent of the program director.

341. The Teacher in Social Restoration (3-6)
The functions of the teacher and the school in prevention and remediation of antisocial behavior. Field work in remedial teaching and experience in social restoration institutions. For social restoration interns only. Mr. Bell.

343. The Disadvantaged Student (3)
Philosophical analyses of disadvantagement and relevant educational theories. Applications and evaluations of special methods and techniques. Mr. Bell.

351. Statistical Methods in Research (3) fall-spring
Methods of describing and condensing sample data and drawing inferences about population characteristics. No background in statistics is presumed. Emphasis on concepts.

353. Reporting Professional Research (3)
Intensive study of and practice in the application of the principles of written exposition to common forms of professional reporting.

391-392. Workshop (1-3)
Cooperative study of current educational problems. Designed to provide elementary and secondary school teachers an opportunity to work at their own teaching levels and in their own fields. Students will be limited to six credits during a summer session but may register for more than one workshop provided there is no duplication in subject matter.

For graduates

400. Psychological Foundations of Education (3) fall-spring
Psychological study of student development and the classroom environment.

411. Personality and Adjustment (3)
Theories of personality and adjustment are examined with emphasis on the adjustment processes in an educational setting. Prerequisite: consent of the program director. Mr. Edmiston.

412. Individual Assessment and Interviewing (3)
Various assessment procedures used in school settings including interviewing, observational techniques, and individual psychological testing. Prerequisite: consent of program director. Mrs. Grandovic.

413. Theories of Psychological Counseling (3) spring
Analysis and synthesis of concepts drawn from counseling theorists. The research and current trends in counseling concerning educational, social, and vocational problems are studied. Prerequisite: admission to program in counselor education. Mr. Edmiston.

423. Diagnostic and Remedial Teaching (3)
The role of the classroom teacher as a diagnostician of corrective learning difficulties. Emphasis is placed on the nature and methods of educational diagnosis and the specifics of diagnostic teaching important to daily classroom instruction at all levels. Opportunities are offered for experiences in diagnosis and program prescription.

424. Linguistics in Education (3)
Emphasis on the nature of language, phonetic applications and the relationships of linguistics to instruction in the language arts.

425. Diagnosis and Adjustment of Reading Difficulties (3)
The psychology of reading as related to learning difficulties; the measurement and diagnosis of reading difficulties; the development of informal tests; materials for corrective and/or remedial instruction. Prerequisite: Educ 431 or consent of program director. Messrs. Kender and Heydenberk.

426. Independent Study and Research (1-6)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated for credit.

431. Developmental Reading (3)
Introductory course spanning the elementary and secondary levels. Emphasis on reading methods, materials, the disadvantaged reader, the gifted reader, and procedures for individualizing reading instruction. Field experience is an integral part of the course. Mr. Kender.

433. Advanced Topics in Reading Instruction (3)
Emphasis on theory and research in the following areas: historical background of reading instruction; the cognitive, affective, and linguistic aspects of reading; implications for the disadvantaged and the gifted reader; and current trends in reading instruction. Field experience is an integral part of the course. Prerequisite: Educ 431 or consent of program director.

437. Language Development of Children (3)
The nature of language and its relation to the development of communciation skills. Critical analysis of related research. Implications for the elementary school.

447. Seminar in Reading Research (3)
An advanced course dealing with critical appraisal and discussion of classical and current studies in reading. Mr. Kender.

448. Counseling in the Community (3)
Introduction to counseling services as provided by communities. Agencies are examined through readings, lectures, and student presentations. Students do a field investigation of a community and a counseling agency. Professional ethics, legal issues, accountability, and organizational structure of agencies. Messrs. Stillman and Mierzwa.

449. Children's Literature in Reading Instruction (3)
A consideration of the role of literature in the instructional program of the elementary schools. Emphasis is given in the use of trade books for individual instruction in reading. Mrs. Parr.

455. Statistics I (3) fall
Data reduction, characteristics of frequency distributions, bivariate correlation and regression. Hypothesis testing, interval estimation errors of inference, statistical power. Normal t, F, and Chi-square sampling distributions.

456. Statistics II (3) spring
One-way and factorial analysis of variance and covariance. Multiple correlation and regression, partial and part correlation. Use of packaged programs for computer analysis. Prerequisite: Educ 455 or consent of the program director.

457. Statistics III (3)
Analysis of variance and covariance in higher order experimental designs including factorial, incomplete factorial, nested, and repeated measures. Linear models approach. Use of packaged programs for computer analysis.

Fig. 2194. — PEAR, (*Pyrus communis.*)

Prerequisite: consent of the program director, Mr. Lutz.

458. Computer Applications (3) spring
Writing and testing computer programs and the use and adaptation of packaged programs; applications in behavioral research and in administration and instruction. Prerequisite: Educ. 455 or 459, or consent of the departmental chairperson.

459. Methods of Statistical Inference and Research Design (3) spring
Introduction to packaged programs for computer analysis. Analysis of variance and covariance in experiemental designs. Multiple correlation and regression. Prerequisite: Educ 351 or 455, or consent of departmental chairperson.

460. Group Counseling and Group Processes (3) fall-spring
Study of group processes as related to counseling and guidance through class participation and demonstration. Prerequisite: Educ 483 previously or concurrently. Messrs. Mierzwa and Stillman.

461. Measurement Specialists Clinic (3-6)
Students construct an evaluative instrument, field test it with an appropriate sample and perform indicated analyses. A test manual is prepared. Prerequisite: Educ 472. Mr. Miller.

469. Practicum in Supervision of Reading Programs (3-6)
For candidates for supervisor's certificate in reading. An overview of the organization of the instructional program and the specific duties involved in the supervisory processes in reading programs. Students will observe and participate in supervisory activities. If taken as a three-hour course, may be repeated for a maximum of six credits.

470. Multivariate Analysis (3)
Multinormal sampling distribution. Multivariate tests of significance, interval estimation, analysis of variance and covariance. Discriminant analysis, canonical correlation, introduction to factor analysis. Use of packaged programs for computer analysis. Prerequisite: Educ 457 or consent of program director. Mr. Lutz.

471. Evaluation in Education (3) fall-spring
Primarily for teachers and counselors. Construction and evaluation of the teacher-made test. Selection of published tests and interpretation of individual and group results. Use and misuse of tests in assessing achievement. Mr. Lutz.

472. Psychometric Theory (3)
Primarily for specialists in measurements and research. Theory of measurement as applied to various kinds of tests and scales. Item analysis: pretesting, scaling and equating; errors of measurement; reliability and validity; prediction; factor analysis in test development. Prerequisite: Educ 455 or permission of the program director. Mr. Miller.

480. Elementary School Guidance (3) spring
Analysis of roles of counselors, teachers, parents, and other specialists and their influence upon the development of the child. Practical concerns are emphasized. Prerequisite: Educ 482 and consent of division director. Mr. Stafford.

481. Assessment in School Psychology (3-6)
Assessment processes used in school psychology. Practice in the administration of tests and preparation of school psychological reports is emphasized. Prerequisite: admission to program in school psychology. Messrs. Mierzwa and Manni.

482. Philosophy and Principles of Guidance (3) fall
Theoretical foundations, principles, and ethics of guidance processes are considered together with the functions, services, and organization of an educational guidance program. Mr. Stafford.

483. Counseling (3) fall-spring
Intensive examination of theories and techniques of counseling. Students will practice counseling skills. Prerequisite: admission to program in counselor education. Messrs. Mierzwa and Stillman.

484. Career Development (3)
Study of the process of selecting and pursuing educational and vocational goals with an emphasis upon decision-making. Career development is examined as a facet of general human development. Evaluating and using occupational, educational and related information. Mr. Palmo.

486. Seminar in School Psychology (3)
Study of the role of the school psychologist with an emphasis upon consultation. Legal aspects of school psychology also are considered. Prerequisite: admission to the school psychology program. Mr. Manni.

487. Counseling and School Psychology Clinic (3-12)
Offered each semester. Messrs. Mierzwa and Manni.

489. Reading Specialists Clinic (3-12)
Mr. Kender.

491-492. Advanced Seminars in Education (3)

493. Research (3)
Basic principles of research and techniques of gathering and analyzing data. Exploration and comparison of various ways of bringing evidence to bear on the identification and solution of educational problems. Emphasis on critical reviews of research reports from various fields and representing various methodologies. A research report is required. Recommended to be taken before approval for master's candidacy.

494. Field Work (3-6)
Identification of significant problem(s) in an educational environment, review of the literature, and development of appropriate research plans. Three credits maximum may be earned in a semester.

495. Educational Research Methodology (3)
For specialists in measurements and research. Study of experimental and quasi-experimental designs, methods of data collection, and instrumentation appropriate for use in educational settings.

496. Seminar in Research (3)
For doctoral students. Research design and application to various kinds of educational problems; data collection and analysis. Seminar includes criticism and evaluation of student proposals and related research. May be repeated for a maximum of nine credits.

498. Internship (3-9)
Designed to give advanced students an opportunity to obtain practical experience. Conference hours for students and staff members will be devoted to discussion of work and problems encountered in the schools. Prerequisite: consent of program director.

Department of Instruction and Curriculum

For advanced undergraduates and graduates

211. Vocational Technical Education (3)
Historical and philosophical foundations. Characteristics of vocational-technical schools and curricula. Role of school and teacher in career development. Problems of vocational choice. Relations with trades, industries and labor organization. Cooperative programs. Prerequisite: consent of program director.

221. Procedures in Trade and Industrial Education (3)
Teaching techniques for trade and industrial subjects. Curriculum and evaluation as related to classroom methods. Student demonstration and micro-teaching. Concurrent with Educ 321, Classroom Practice. Prerequisite: consent of program director.

311. Origins of Western Schools (3-6)
A study and travel seminar for experienced teachers. Emphasis is upon the nature and methods of Hellenistic and medieval schools. Relevant traditions in language, art and philosophy are considered. Influences on American institutions are shown. Undertaken in cooperation with selected European universities. Summer session. Prerequisite: consent of the dean of the School of Education.

313. Arts and Crafts for the Handicapped (3)
Study of various artistic media (arts, crafts, music, puppetry, dramatics) which are helpful in promoting development of handicapped individuals.

315. Teaching the Emotionally and Socially Maladjusted (3)
The nature and causes of emotional and social maladjustment; methods of gaining insight into and modification of behavior; appropriate curriculum, methods, materials, and available resources. Field observations required. Prerequisite: admission to the special education program or consent of the program director. Mr. Nichols.

316. Motor Development of Handicapped Children (3)
Methods of promoting sequential motor skills in handicapped children. Prerequisite: consent of the program director.

317. Teaching the Mentally Retarded (3)
Special needs of and vocational possibilities for retarded individuals; current educational practices, curriculum methods of teaching; materials for promoting maximal social competency;

available resources. Field observations. Prerequisite: admission to the special education program or consent of the program director.

318. Language and Social Development of Handicapped Children (3)
Methods of promoting sequential language and social skills in handicapped children. Prerequisite: consent of the program director.

319. Career Education for the Handicapped (3)
Promoting attitudes, work habits, and skills which enhance employability of the handicapped; appraisal of methods for matching individuals to jobs; job market for the handicapped; various curricular and administrative designs. Prerequisite: admission to the special education program or consent of the program director.

320. Criterion-based Evaluation in Career Education (3)
Development and critical examination of criterion-based instruments for assessing students' abilities. Designed to develop skills in construction and implementation of criterion-based instruments for assessing performance in various phases of career education. Prerequisite: consent of program director.

321. Classroom Practice (1-3)
Experience in elementary and secondary classrooms as related to theories of child and adolescent development, classroom didactics, and philosophies of education. Problem-centered discussions, and observations. Prerequisite: consent of the dean of the School of Education.

323. Intern Seminar (3)
Critical analysis and discussion of classroom instructional practices. Discussion and illustration is based on the experiences of participants as they engage in intern teaching. For students enrolled in teaching intern programs only.

325. Intern Teaching (3-6)
Intensive practice in the application of the principles of teaching. Each intern is appointed to a full-time teaching position for one or two semesters. Supervision is provided both by the employing school district or community college and by the university. For undergraduate students admitted to certification programs in career education only.

327. Occupations and Manpower (3)
Nature of Work in America. Structure of the workforce. Work values and attitudes. Sources of occupational information. Methods of surveying manpower needs. Manpower programs. Labor organizations. Emphasis on the relationships between educational systems and the work world. Prerequisite: consent of program director.

331. Shop and Laboratory Management (3)
Systems and procedures for layout, organization, maintenance, inventory, and safety of school shops and laboratories.Issues in utilization and specialization. Instructional methods. Relationship of shop practices to curricular objectives and career standards. Prerequisite: consent of program director.

333. Special Topics in Secondary Education (3)
Examination of an area of secondary education that is of special interest to students and faculty. May be repeated for credit. Prerequisite: consent of program director.

361. Curriculum Construction for Career Education (3)
Identification and clarification of goals and competencies. Methods of curriculum organization. Development of curriculum resources. Providing for individual differences. Organizing special experiences. Development of cooperative programs. Evaluating, recording, and reporting student progress. Prerequisite: consent of program director.

391-392. Workshop (1-3)
Cooperative study of current educational problems. Designed to provide elementary and secondary school teachers an opportunity to work at their own teaching levels and in their own fields. Students will be limited to six credits during a summer session but may register for more than one workshop provided there is no duplication in subject matter.

393. Instructional Media (3)
Study of principles underlying the use of graphic and sound projection in teaching. Utilization of commercial, student, and teacher made materials. Applications of new instructional media such as television, teaching machines, and computer-assisted instruction to classroom teaching. Mr. Ray.

For graduates

401. Sociological Foundations of Education (3) fall-spring
Analysis of the American school as a social institution, its cultural heritage, its purposes and processes in relation to social change and educational leadership. Examination of the school's role in socialization and its responsibilities for relevance to social issues and to subcultural needs. A. Rinehart.

406. Historical Foundations of Education (3) fall-spring
The developments of primary, secondary, and higher education; the aims, curricula, methods, and systems of education in America from Colonial time to the present, in relation to the social conditions and processes. Mr. Leight.

407. Philosophical Foundations of Education (3) fall-spring
Comparative philosophical analysis of educational aims, practices, and institutions. Major philosophical theorists whose work has influenced educational thought from ancient times to the present are studied. Messrs. Leight and Stoops.

408. Comparative Education (3) fall-spring
A survey of educational practices abroad including all programs from nursery to graduate education. Major emphasis is placed upon systems of articulation, social foundations, legal foundations, and structure in government. The nature and purposes of the schools are considered with particular reference to cultural patterns. Focus is also placed upon major problems and trends. Mr. Warfel.

410. Structure and Syntax of the Academic Disciplines (3)
Professors from other departments of the university are presented in discussions coordinated by the School of Education. The patterns which organize and identify the academic disciplines are emphasized. Study is given the nature and significance of the conceptual structures which guide inquiry or research in certain major fields of scholarship. Implications for planning of curricula and preparations of teaching materials are considered.

412. Individual Assessment and Interviewing (3)
Various assessment procedures used in school settings including interviewing, observational techniques, and individual psychological testing. Prerequisite: consent of program director. Mrs. Grandovic.

414. Child Development (3) fall-spring
A study of physical, intellectual, emotional, and social aspects of child development as they relate to the elementary schools. Mr. Castaldi.

415. Developmental Learning Clinic (3)
Special education students with training in learning disabilities cooperate with school psychologists, reading specialists, and counselors in the assessment and formulation of prescriptive programs for children with special learning problems. Prerequisite: consent of program director. May be repeated for credit.

416. Classroom Didactics (3-6)
Initial preparation of interns for classroom teaching. Secondary interns are trained in special methods of subject fields and the reading problems of secondary students. Elementary interns study the place of subjects in the elementary school. Open to interns only.

418. Values and Educational Purpose (3)
Modes of philosophical analysis used in justification of educational purposes. The presence of metaphysical, epistemological, and metaethical premises in educational opinion. Canons of rational inquiry as applied to educational decisions. Manifestations of values in contemporary school curricula. Messrs. Leight and Stoops.

419. Youth in Society (3)
Social development, characteristics, and problems of adolescents and young adults. Impact of relationships with siblings, peers, adults, subcultures, in the context of changing institutions and values.

422. Education of Exceptional Children (3)
Curriculum, methods of instruction, and materials for individuals who differ markedly from the normal intellectually, physically, emotionally, or socially; the nature and causes of these differences; available resources. Field trips; direct work with exceptional encouraged. Mrs. Grandovic.

423. Diagnostic and Remedial Teaching (3)
The role of the classroom teacher as a diagnostician of corrective learning difficulties. Emphasis is placed on the nature and methods of educational diagnosis and the specifics of diagnostic teaching important to daily classroom instruction at all levels. Opportunities are offered for experiences in diagnosis and program prescription.

426. Independent Study and Research (1-6)
Individual or small group study in the field of specialization. Approved and supervised by the major adviser. May be repeated for credit.

427. Participation in Teaching (3)
Study, directed observation of, and initial practice in the various phases of teaching in a

campus laboratory-demonstration school or in area elementary and secondary schools.

428. Intern Teaching (3-6)
Intensive practice in the application of the principles of teaching. Each intern is appointed to a full-time teaching position for one or two semesters. Supervision is provided both by the employing school district or community college and by the university.

429. Intern Teaching Seminar (3)
Critical analysis and discussion of classroom instructional practices. Discussion and illustration will be based on the experiences of participants as they engage in intern teaching.

434. Mathematics in Elementary Education (3)

435. Social Studies in Elementary Eduation (3)
Mr. Warfel.

436. Science in Elementary Education (3)

438. Fine Arts in Elementary Education (3)

444. The Elementary School Curriculum (3)
Problems of curriculum development in the first six grades; subject matter placement, program-making for difficult types of schools, regular vs. special subjects, articulation, and similar problems. Mrs. Lifland.

451. Learning Disabilities (3)
Types of specific learning disabilities and their effects on development and learning; physiological basis of learning and learning theory; various theoretical approaches; diagnostic and remedial procedures.

452. Learning Disabilities Practicum (3)
A ninety-hour practicum in the assessment and remediation of learning disabilities.

462. Criterion and Performance Based Evaluation (3)
Overview of measurement and evaluation theory and techniques with particular reference to criterion-based performance evaluation in vocational and career education.

464. Foundations of Curriculum Construction (3) fall-spring
Principles of curriculum construction which underlie the reorganization of the program of studies for elementary and secondary schools; origin and background of the curriculum; methods of organization; curriculum planning and development; and pertinent applications. K-12. Mr. Pickering.

491-492. Advanced Seminars in Education (3)

493. Research (3)
Basic principles of research and techniques of gathering and analyzing data. Exploration and comparison of various ways of bringing evidence to bear on the identification and solution of educational problems. Emphasis on critical reviews of research reports from various fields and representing various methodologies. A research report is required. Recommended to be taken before approval for master's candidacy.

494. Field Work (3-6)
Identification of significiant problems in an educational environment, review of the literature, and development of appropriate research plans. Three credits maximum per semester.

496. Seminar in Research (3)
For doctoral students. Research design and application to various kinds of educational problems; data collection and analysis. Seminar includes criticism and evaluation of student proposals and related research. May be repeated for a maximum of nine credits.

498. Internship (3-9)
Designed to give advanced students an opportunity to obtain practical experience. Conference hours for students and staff members will be devoted to discussion of work and problems encountered in the schools. Prerequisite: consent of program director.

ELECTRICAL ENGINEERING

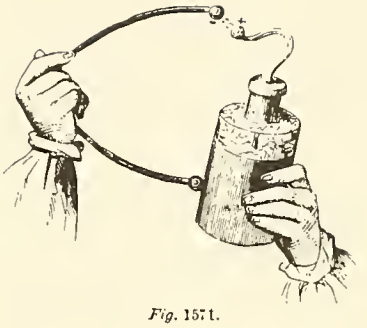

Fig. 157 t.

Professors. Alfred K. Susskind, S.M., chairman; John J. Karakash, D. Eng., distinguished professor and dean of the College of Engineering and Physical Sciences; Walter E. Dahlke, Ph.D.; Nikolai Eberhardt, Ph.D.; Arthur I. Larky, Ph.D.; Daniel Leenov, Ph.D.

Associate professors. Bruce D. Fritchman, Ph.D.; Frank H. Hielscher, Ph.D.; Carl S. Holzinger, Ph.D.; John G. Ondria, Ph.D.; Kenneth K. Tzeng, Ph.D.

Assistant professors. Hans R. Gnerlich, Ph.D.; Joseph C. Mixsell, Jr., Ph.D.; Peggy A. Ota, Ph.D.

Instructor. Donald L. Talhelm, M.S.

Lecturers. Robert A. Donia, M.S.; John K. Redmon, M.S.; John F. Sipics, B.S.

The department of electrical engineering offers two undergraduate degree programs, one leading to the bachelor of science in electrical engineering, the other to the bachelor of science in computer engineering.

The two programs are nearly identical until the middle of the junior year, and students can freely move from one to the other.

The electrical engineering curriculum prepares graduates for entry into such areas as electronic devices, communication, information and computing systems, control systems, electronic instrumentation, and electrical power systems.

The computer engineering curriculum contains the basic elements of both hardware and software. Because of the pervasiveness of computers throughout modern technology, graduates find career opportunities not only in the computer industry, but also in a broad range of industrial as well as governmental activities.

Both undergraduate programs also can serve as stepping stones into such related areas as bioengineering, computer science, system engineering, or management science.

Courses in the department required for the degree in electrical engineering contain the fundamentals of computing techniques, linear circuits and systems, electronic circuits, signal theory, physical electronics, electromagnetic theory, and energy conversion. Some of these courses include laboratory work; two upper-level laboratory courses also are required. To facilitate increased emphasis on experimental work, the undergraduate laboratories are undergoing renovation and reorganization.

Requirements for the degree in computer engineering include courses in computing techniques, linear circuits and systems, logic design, electronic circuits, signal theory, computer structure, systems programming, discrete mathematics, and numerical analysis. Laboratory sessions are part of some of these courses; two upper-level laboratory courses also are required.

A basic assumption underlying the curricula is that the variety of activities in which modern engineers are engaged will continue to remain large, and so provision for mobility of the individual is made by concentrating on broad fundamentals and not on the details of current engineering practice. As a consequence, subjects in physics and mathematics form a substantial block of courses in both curricula, because no matter which direction the individual will follow, a foundation in the basic sciences and mathematics is essential.

Within electrical engineering, the physical sciences provide the foundation for studies of devices such as transistors, microwave components, and energy converters. Mathematics provides the basis for the analytical study of device models and the tools for the analysis, design and exploitation of systems such as computers, communication networks, and computer software.

About a quarter of the two curricula consists of approved electives and other electives. The former are chosen with the consent of an adviser; the latter require no formal approval. Together, these two groupings provide opportunity for tailoring the individual's program according to his or her interests and goals. Some students use the electives for acquiring additional background in preparation for graduate study. Others select senior-year courses in preparation for entry into industry at the completion of the four-year program.

Students are free to select from courses offered by other departments, and are encouraged to do so whenever it serves their individual needs. In this manner, they can prepare themselves for activities which straddle departmental boundaries, or for entry into professional schools such as medicine or management. To maximize the benefits that the flexibility of the curriculum can offer, thorough planning in consultation with an adviser is recommended.

In common with all engineering curricula, both degree programs require a total of at least eight courses in the humanities or the social sciences. Some students utilize this sequence to complete a minor program in one of the other colleges, such as a program in government, economics, or foreign languages. Advisers assist individuals in making appropriate arrangements.

Recommended sequences of courses

freshman year (see page 40)

sophomore year, first semester (16 credits)

EE 11	Principles of Computing Techniques (3)
Math 23	Analytic Geometry and Calculus III (4)
Phys 21, 22	Introductory Physics II and Lab (5)
Eco 1	Economics (4)

Fig. 1348. — THE TREE-TOAD, (*H. versicolor.*)

sophomore year, second semester (16-17 credits)

EE 20	Introduction to Circuit Theory (4)
Math 205	Linear Methods (3)
	General Studies Requirement (3)
	sophomore electives * (6-7)

*Note: These electives are to include Mech 103, Principles of Mechanics, for students seeking the electrical engineering degree, or EE 141, Switching Theory and Logic Design, for students seeking the computer engineering degree.

junior year, first semester (14-17 credit hours)

EE 104	Linear Systems and Signals (4)
EE 105	Electronic Circuits (4)
Math 231	Probability and Statistics (3) or
Math 309	Theory of Probability (3)
	General Studies requirement (3)
	elective (0-3)**

**Please refer to description of normal engineering programs, page 40.

Bachelor of science in electrical engineering

junior year, second semester (17 credit hours)

EE 103	Physical Electronics (3)
EE 106	Electromechanics and Machines (3)
EE 236	Electromagnetic Fields I (3)
EE 142	Junior Lab (2)
	approved electives* (6)

*Note: At least one subject must be in physics, chemistry or biology. Quantum mechanics is the best choice for those planning a program in electronics.

summer

EE 100	Industrial Employment

senior year, first semester (15-18 credits)

EE 111	Proseminar (1)
EE 151	Senior Lab I (2)
EE 237	Electromagnetic Fields II (3)
	approved electives* (6)
	elective (0-3)**
	General Studies requirement (3)

senior year, second semester (18 credits)

	approved electives* (12)
	Elective (3)
	General Studies requirement (3)

*Note: Approved electives are subjects predominantly in the areas of science and technology. They are not restricted to offerings in the department of electrical engineering. Students must choose at least one elective in mathematics and at least one elective in either materials, thermodynamics, fluid mechanics, or physical chemistry.

**Please refer to description of normal engineering programs.

Bachelor of science in computer engineering

junior year, second semester (17 credits)

EE 201	Computer Architecture (3)
EE 315	Principles of Computer Software (3)
EE 317	Analytical Methods for Information Sciences (3)
EE 142	Junior Lab (2)
	approved elective† (3)
	elective (3)

summer

EE 100	Industrial Employment

senior year, first semester (15-18 credit hours)

EE 111	Proseminar (1)
EE 151	Senior Lab I (2)
Math 230	Numerical Methods (3)
	approved electives† (6)
	elective (0-3)**
	General Studies requirement (3)

senior year, second semester (18 credit hours)

	approved electives* (12)
	elective (3)
	General Studies requirement (3)

†Approved electives are subjects in the area of science and technology. They are not restricted to offerings in the department of electrical engineering.

Course descriptions

11. Principles of Computing Techniques (3) fall
Introduction to computational devices and their use. Topics include: computer organization, information representation, computational operations, data structures, and assembly and high-level language programming techniques. Prerequisite: Engr 1 or equivalent.

20. Introduction to Circuit Theory (4) spring, summer
Introduction to methods for analyzing lumped circuits. Topics include: circuit elements, formulation of differential equations, mesh and node analysis, network functions, natural frequencies, complete response calculations, pole-zero analysis, network theorems. Includes a weekly laboratory and/or problem-solving session. Prerequisite: Math 23.

100. Summer Work
Students are expected to spend at least eight weeks getting experience in some industrial organization, normally during the vacation following the junior year. A written report on the experience gained is required.

103. Physical Electronics (3) spring
Energy levels and band theory. Introduction to quantum statistics; electron emission and photoelectric effect; electron ballistics and applications. Conduction in metals and semiconductors; theory of p-n junctions and transistors; static and dynamic characteristics; equivalent circuits. Prerequisite: junior standing.

104. Linear Systems and Signals (4) fall
Transform theory, including Fourier and Laplace transforms. Application of transform techniques to the solution of linear system and circuit problems, including the use of Bode and pole-zero plots. Sampling theorem and its application to digital signal processing. Prerequisite: EE 20.

105. Electronic Circuits (4) fall
Introduction to methods for analyzing and designing circuits containing semiconductor devices such as diodes, bipolar transistors, and field-effect transistors for both small and large-signal applications. Topics include device models, operating-point stabilization, basic amplifier configurations, power relationships, graphical and mathematical analysis techniques, introduction to multistage amplifiers and feedback. Includes a weekly laboratory. Prerequisite: EE 20.

106. Electromechanics and Machines (3) spring
Principles of electromagnetism and their application in electromechanical devices. Analysis and design of transformers, solenoidal actuators, multi-phase power systems, AC and DC rotating machinery, and machine control. Prerequisite: EE 20.

111. Electrical Engineering Proseminar (1) fall
A weekly seminar to acquaint students with current topics in electrical engineering. Students prepare and present oral and written reports which are judged on quality of presentation as well as technical content. Prerequisite: senior standing.

141. Switching Theory and Logic Design (3)
Boolean algebra and its application to networks with bivalued signals. Function simplification and design of combinational logic. Sequential machines and their realization in pulse and level circuits. Design of simple digital systems.

142. Junior Lab (2) spring
Experimental work related to EE 103, 104, 105, 106, 141 and 201, intended to strengthen proficiency in these fields. Two three-hour laboratory sessions per week. Prerequisite: junior standing.

151. Senior Laboratory I (2) fall
Laboratory projects in any phase of electrical and computer engineering, frequently in the areas of digital systems, communications, instrumentation, electronic circuits, and software. Projects are selected from topics suggested by the students, staff, or industrial concerns. Two three-hour sessions per week. Prerequisite: senior standing.

152. Senior Laboratory II (2) spring
Two choices open, each occupying two three-hour sessions per week.
1. Project laboratory. Similar to EE 151.
2. Microwave laboratory. Introduction to the standard techniques of measurement in the microwave range, such as measurement of impedance with the slotted line and the hybrid tee; two-port parameters; attenuation by substitution and heterodyning. Prerequisite: EE 346 previously or concurrently.

160. Introduction to Electrical Engineering (4) fall-spring
Survey subject for students not majoring in electrical engineering. Elementary network theory. Behavior of simple linear networks. Principles of semiconductor devices and their use in functional circuits. Electromechanical energy conversion. Selected applications. Includes a weekly recitation session for review and discussion of assignments. Prerequisites: Math 23 and Phys 21.

162. Electrical Laboratory (1) fall-spring
Experiments on circuits, machines, and electronic devices. Prerequisite: EE 160 concurrently.

For advanced undergraduates and graduates

201. Computer Architecture (3)
Digital building blocks, conventional computer structure and information flow. Mechanization of arithmetic, storage, and control functions. Input-output systems and controllers. Priority interrupt, direct memory access and other overlapping techniques. Architecture of small ("mini") computers; key features of large ("maxi") machines. Digital design simulation. Prerequisites: EE 11 or Math 105; EE 141 previously or concurrently. Mr. Larky.

205. Pulse and Digital Circuits (3)
Concentration on large-signal, nonlinear, pulse-type circuitry employing devices such as diodes, transistors, silicon-controlled rectifiers, and operational amplifiers. Among topics covered are the internal workings and interface properties of major integrated digital circuit families (TTL, ECL and CMOS) and propagation of waveforms on transmission lines. Prerequisite: EE 105. Mr. Holzinger.

212. Control Systems (3)
Introduction to feedback control. Dynamic analysis of linear feedback systems in the time and frequency domain, with emphasis on stability and steady-state accuracy. Major analytical tools: signal-flow graphs, root-locus method, Nyquist plot, Bode analysis. Cascade compensation techniques. Introduction to sampled data and state-variable concepts. Prerequisite: EE 104. Mr. Talhelm.

233. Power System Analysis I (3)
Determination of transmission line constants; transmission line equations. Synchronous generator representation during steady state and transient conditions. Network reduction by matrix partitioning, network solutions by matrix transformations. Symmetrical components and system faults. Sequence impedances of transmission lines, transformer banks and synchronous generators. Prerequisite: EE 106. Mr. Sipics.

234. Power System Analysis II (3)
Application of short-circuit impedance matrix to fault studies. Numerical methods for solution of the load flow problem. Economic despatch and unit commitment. Basic system stability consideration. Prerequisite: EE 233. Mr. Donia.

236 Electromagnetic Fields I (3) spring
EM-Fields I and II provide theoretical foundations for understanding of electricity. EM-Fields I deals with mathematical foundations, such as vector analysis, and the theory of fields which are solutions to Laplace's equation (potential fields). Prerequisite: junior standing.

237. Electromagnetic Fields II (3) fall
Continuation of Electromagnetic Fields I. Time-varying fields which are solutions of Maxwell's equations. Main topics include: uniform plane waves in loss free and lossy media; skin effect; Poynting's vector; guided waves in transmission

lines and waveguides, including optical waveguides; reflection and refraction; microwave and optical resonators; antennae; Gaussian beams (laser beams). Prerequisite: EE 236 or equivalent.

244. Communication Networks (3)
Introductory theory of two-terminal and four-terminal network synthesis. Transmission lines as network elements. Analog and digital filter theory. Prerequisites: EE 104 and 105. Mr. Talhelm.

300. Apprentice Teaching in EE (1-3)

307. Transistor Circuit Application (3)
Review of static and dynamic behavior of p-n junctions. Transistor physical electronics, volt-ampere characteristics, and circuit models. Dependence of circuit-model parameters on structure and operating conditions. Tuned amplifiers, feedback amplifiers, and oscillators. Prerequisite: EE 105. Mr. Ondria.

308. Transistor Theory (3)
Theory of semiconductor devices. Small-signal and large-signal properties of p-n junction diodes including switching characteristics. Large-signal approximation for bipolar transistors, including Ebers-Moll and charge-control models. Deviations from low-level models at high injection levels. Other devices, including Schottky-barrier diodes, field-effect transistors, and p-n-p-n structures. Prerequisite: EE 103 and Phys 31. Mr. Leenov.

311. Compiler Design (3)
Principles of artificial language description and design. Sentence parsing techniques, including operator-precedence, bounded-context and syntax-directed recognizer schemes. The semantic problems as it relates to interpreters and compilers. Recent developments, including dynamic storage allocation, table grammers, code optimization, compiler-writing languages. Prerequisite: consent of department chairman.

315. Principles of Computer Software (3)
Machine, assembly and macro language concepts. Study of assemblers, macro processors, and loaders, and techniques for their construction. Introduction to operating systems as time permits. Prerequisite: EE 11 or consent of department chairman. Ms. Ota.

317. (IS 317, Math 317) Analytical Methods for Information Sciences (3)
Series of topics in discrete mathematics chosen for their applicability to computer science, coding theory, and information retrieval. Sets; binary relations; lattices; Boolean algebras and application to logic design; semigroups and relevance to automata; groups and application to coding; fields and relevance to circuits and codes; graphs and application to file searching. Prerequisite: senior standing or consent of department chairman. Mr. Tzeng.

319. Digital System Design (3)
Design of combinational and sequential digital systems using standard logic elements, both SSI and MSI; characterization and application of flip-flops and other memory devices; input-output devices and the problems of interfacing to a computer; special-purpose digital systems. Prerequisite: EE 141. Mr. Larky.

321. Current Topics in Magnetics (3)
Topics drawn from current areas of magnetic device theory and application, such as orthoferrite bubbles, magneto-optics, magnetic thin films, ferrites, and permanent magnets. Text material taken primarily from the current literature, with emphasis on computer applications. No specialized background assumed. Prerequisite: consent of department chairman. Mr. Holzinger.

342. Communication Theory (3)
Theory and application of analog and digital modulation. Sampling theory with application to analog-to-digital and digital-to-analog conversion techniques. Time and frequency division multiplexing. Introduction to random processes including filtering and noise problems. Introduction to statistical communication theory with primary emphasis on optimum receiver principles. Prerequisites: EE 104 and Math 309 or 231. Mr. Fritchman.

343. Digital Signal Processing (3)
Study of one- and two-dimensional orthogonal signal expansions and their discrete representations, including the Discrete Fourier Transform and Walsh-Hadamard Transforms. Development of fast algorithms to compute these, with applications to feature extraction and two-dimensional image processing. Introduction to the z-transform representation of numerical sequences with applications to input/output analysis of discrete systems and the design of digital filters. Analysis of the internal behavior of discrete systems using state variables for the study of stability, observability and controllability. Prerequisite: EE 104. Mr. Fritchman.

346. Microwave Circuits and Techniques (3)
Impedance transformation along waveguides. Matching techniques. Resonant cavities as circuit elements. Scattering and transfer matrices. Periodic structures. Selected microwave devices. Basic techniques of microwave measurements. Prerequisite: EE 237. Mr. Eberhardt.

350. Special Topics (3)
Selected topics in the field of electrical and computer engineering not included in other courses.

351. Microelectronics (3)
Technology of semiconductor devices and of integrated circuits, including crystal growth and doping, phase diagrams, diffusion, epitaxy, thermal oxidation and oxide masking, photolithography, thin film formation. Effects of these processes on the design of transistors and integrated circuits. Prerequisite: EE 103 and Phys 31 or consent of department chairman. Mr. Hielscher.

355. Applied Integrated Circuits (3)
Emphasis on understanding of terminal characteristics of integrated circuits with excursions into internal structure only as necessary to assure proper utilization in system design. Classes of devices studied include operational amplifiers, digital-to-analog and analog-to-digital converters, linear multipliers, modulators, and phase-locked loops. Prerequisites: EE 104 and 105. Mr. Holzinger.

For graduates

Graduate study leading to the master of science, master of engineering and doctor of philosophy degrees is available in the electrical engineering department. None of the advanced-degree programs has a fixed curriculum, and courses are selected by the individual in consultation with advisers.

Study leading to the master of science degree emphasizes the scientific aspects of electrical and computer engineering and requires the submission of a six credit-hour thesis. Programs leading to the master of engineering include design-oriented courses and cover a range of areas. Completion of an engineering project is required.

Subject to approval by departmental advisers, graduate degree programs frequently include as part of the "major" courses offered by other departments. This is particularly appropriate in those areas where courses in physics and mathematics provide a foundation for advanced work.

Students in the Ph.D. program are required to take the qualifying examination within one year after obtaining the master's degree. This examination tests competency in general areas of electrical engineering. A second examination in the candidate's area of specialization is taken at some time up to the last year of his or her program. Competence in a foreign language is not a required part of the Ph.D. program in electrical engineering.

Members of the department are particularly interested in advanced work in the following areas: semiconductor devices; microwave components and circuits; electrooptics; instrumentation; computer languages; computer hardware and software systems; communications and decision theory; fault-tolerant computing; pattern recognition; algebraic coding theory; switching theory and logical design; solar-radiation monitoring.

The facilities of the electrical engineering department are located primarily in James Ward Packard Laboratory of electrical and mechanical engineering. The electrical engineering department also shares the facilities of the Sherman Fairchild Laboratory for Solid-State Studies. In common with all of the campus activities, access to Lehigh's CDC 6400 computer is available.

Facilities for experimental work in electronics and communication cover the spectrum through microwave frequencies and into optical wave lengths. Special research facilities, including a shielded room, are available for the study of devices, noise in semiconductor networks, and digital functions. The department has two PDP-8 minicomputers, microprocessor systems, and a variety of ancillary building blocks.

Microelectronics facilities for the preparation and investigation of semiconductor devices, located in the Sherman Fairchild Laboratory, include equipment for diffusion, oxidation, photolithography, metallization, sputtering, and device assembly and testing. In addition, facilities of other departments are available. These include X-ray facilities, electron microscope, scanning electron microscope, electron microprobe, and Auger spectrometer.

403. Design of Operating Systems (3)
Principles of operating systems with emphasis on hardware and software requirements and design methodologies for multiprogramming systems. Global topics include the related areas of process management, resource management, and file systems. Prerequisite: EE 315 or equivalent. Ms. Ota.

407. Linear and Nonlinear Optics (3)
Gaussian beams. Optical waveguides and resonators. Introduction to laser physics. Crystal optics with attention to nonlinear effects. Harmonic and subharmonic generation. Parametric amplifications. Brillouin and Raman scattering. Classical diffraction theory. Holography with applications. Mr. Eberhardt.

409. Advanced Electromagnetic Theory (3)
Maxwell's equations in the scope of modern physics. Wave propagation in anisotropic and gyrotropic media. Introduction to nonlinear media. Atmospheric propagation and scattering. Selected topics from antenna theory. Mr. Eberhardt.

411. Information Theory (3)
Introduction to information theory. Topics covered include: development of information measures for discrete and continuous spaces, study of discrete-stochastic information sources, derivation of noiseless coding theorems, investigation of discrete and continuous memoryless channels, development of noisy channel coding theorems. Mr. Fritchman.

413. Active Networks (3)
Synthesis of active networks to prescribed frequency characteristics. Stability and realizability criteria. Parameter drift effects. Mr. Larky.

425. Power System Analysis I (3-6)
Distribution-system concepts and components: transformers; protectives devices; voltage control; optimum loading; grounding. Protective relaying: operating principles and system calculations including fault calculations using symmetrical components. Surge phenomena: traveling-wave theory; grounding; surge-reduction design and arrester application; insulation coordination. Economics of power systems: analysis and evaluation of financial structure; rate of return; rate structures; depreciation. Mr. Redmon.

426. Power System Analysis II (3-6)
Analysis of synchronous machines. Steady-state and transient modes of operation; per unit representation; d-q equations; balanced and unbalanced short-circuit stability; saturation. Stability criteria of power systems. State functions and state variables; system modelling; computer techniques; state-of-the-art analysis techniques; dynamic stability. Mr. Redmon.

431. Topics in Switching Theory (3)
Emphasis on structural concepts motivated by recent advances in integrated circuit technology. Major topics include: logical completeness, error detection and location; decomposition techniques; synthesis with assumed network forms; fault masking in switching circuits. Prerequisite: EE 141 or equivalent. Mr. Susskind.

432. Finite State Machines (3)
Description of sequential behavior; Gedanken experiments; error control; information losslessness, iterative systems. Synthesis of sequential machines in canonic forms and as asychronous circuits. Prerequisite: EE 141 or equivalent. Mr. Susskind.

435. Coding Theory (3)
General theory of error-correcting codes for error control in digital computer and communication systems. Topics include a review of modern algebra as required in the discussion of codes; the structure and properties of linear, cyclic, and convolutional codes for random or burst-error correction (or both); decoding algorithms and their circuit implementations. Prerequisite: EE 317 or Math 243 or equivalent. Mr. Tzeng.

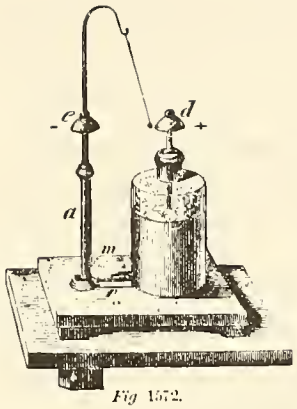

Fig 1572.

444. Microwave Devices (3)
Optical masers. Cavity- and traveling wave masers. Devices using ferrimagnetic resonance: isolators, circulators, electronically controlled phase shifters. Parametric amplifiers. Amplifiers and oscillators using active semiconductor devices. Mr. Eberhardt.

447. Nonlinear Phenomena (3)
Investigation of nonlinear effects in active and passive lumped and distributed circuits with emphasis on methods of analysis as well as physical understanding of jump phenomena, van der Pol's theory, stability criteria, phase locking. Transmission line and optical waves in nonlinear media: shock waves, harmonic generation and optical parametric amplification. Mr. Eberhardt.

448. (ME 448) Optimal Control and Design Theory (3)
Parameter optimization in design and optimal open-loop and feedback control via the extrema of unconstrained and constrained functions and functionals (calculus of variations). Matrix and state space formulation, Lagrange multipliers, Pontryagin maximum principle, Hamilton-Jacobi theory, matrix Ricatti equations, sensitivity analysis. Survey of observability and controllability, dynamic programming, and Kalman filter. Intended for engineers with a variety of backgrounds. Prerequisite: ME 340 or 343 or EE 212 or ChE 286. Messrs. Benner, Brown and Johnson.

450. Special Topics (3)
Selected topics in the field of electrical engineering not covered in other courses.

451. Physics of Semiconductor Devices (3)
Transport theory, lattice vibrations, electronic conduction, thermoelectric effects. Theory of recombination. Energy band structure. Applications to p-n junctions. Prerequisites: Phys 31 and EE 103 or equivalent. Mr. Dahlke.

452. Theory of IMPATT and Gunn Diodes (3)
Hot electrons, secondary ionization, avalanche breakdown, electron transfer by intervalley scattering. Applications to microwave oscillators and amplifiers, such as avalanche and Gunn diodes. Prerequisite: EE 451. Messrs. Dahlke and Leenov.

453. Theory of Field Effect and Tunneling Devices (3)
Properties of semiconductor surfaces; tunneling theory. Applications to tunnel diodes and field-effect transistors. Prerequisite: EE 451. Mr. Dahlke.

454. Theory of Optoelectronic Devices (3)
Optical electronics. Theory of radiation, radiative absorption and emission in semiconductors. Applications to optical electronic devices: electroluminescence, light emitting diodes, lasers. Detection and modulation of optical radiation, solar cells and photodetectors. Prerequisite: EE 451. Mr. Dahlke.

Fig. 240. — NATIVE AUSTRALIAN.

459. Fundamentals of Integrated Circuits (3)
Discussion of basic concepts which govern the design and performance of integrated circuits. Microelectronics technology, device physics and equivalent circuit models, effects of processing and parasitic elements on device performance. Circuit design considerations, with examples drawn from current linear and digital integrated circuits. Mr. Hielscher.

460. Engineering Project (3-6)
Project work in an area of student and faculty interest. Selection and direction of the project may involve interaction with industry. Prerequisite: consent of department chairman.

461. Theory of Electrical Noise (3)
Definitions: noise temperature, spectral density. Noise sources: quantum, thermal, shot, generation-recombination, flicker noise. Representation and optimization of noisy networks. Prerequisites: Phys 31 and EE 103 or equivalent. Mr. Dahlke.

462. Noise in Microwave Devices and Networks (3)
Noise in electron tubes, bipolar and MOS transistors, mixers, parametric amplifiers, tunnel diodes, and masers. Prerequisite: EE 461. Mr. Dahlke.

ENGLISH

Professors. Frank S. Hook, Ph.D., chairman; James R. Frakes, Ph.D., Edmund W. Fairchild professor of American Studies; David M. Greene, Ph.D.; Albert E. Hartung, Ph.D., distinguished professor; John W. Hunt, Ph.D., dean of the College of Arts and Science; John F. Vickrey, Ph.D.

Associate professors. Peter G. Beidler, Ph.D.; Addison C. Bross, Ph.D.; Jack A. DeBellis, Ph.D.; Edward J. Gallagher, Ph.D., director of the Humanities Perspectives on Technology program; Robert R. Harson, Ph.D.; E. Anthony James, Ph.D.

Assistant professors. Rosemarie Arbur, Ph.D.; Elizabeth N. Fifer, Ph.D.; Jan S. Fergus, Ph.D.; George B. MacDonald, Ph.D.; Rosemary J. Mundhenk, Ph.D.; Barbara H. Traister, Ph.D.

Instructor. Mildred K. Sanders, M.Ed.

The department of English offers majors in literature, journalism, and drama.

English and American Literature

Courses in English language and literature may be considered a general preparation for any decent kind of living. These courses require close attention to words, and at the same time encourage that loving respect for the true naming of things which is the source of all clear and honest thought.

In literature itself, which is words that we wish to hear again, and yet again, without change, we may find a happy companionship with minds that can help our own grow straight with grace. A head that is full of poetry is a good one to have to live with.

The undergraduate major in English

The major in English is designed to give interested students: 1. experience in reading, analyzing, and formulating thoughts about what Matthew Arnold called "the best that has been thought and said"; 2. an understanding of how literary artists find the appropriate words to express their thoughts and feelings; and 3. a basic knowledge of the historical development of British and American literature.

Students who major in English often go on to careers in teaching, writing, law, or business, but the analytical and communication skills acquired in the study of literature and writing will be of use in almost any profession or human activity. Depending on their interests, abilities, and career plans, students who major in English are encouraged to consider double majors or minors in other fields. The major in English is flexible enough to allow this cross-discipline study with ease.

The English major has considerable freedom to choose from an extensive list of courses. To ensure breadth of coverage, each major is required to take Engl 25 and 26, Survey of British Literature, and Engl 23, Survey of American Literature, first semester. These three courses are designed to acquaint the student with the important British and American writers, and with certain movements and trends in literature, before the twentieth century.

To ensure depth of understanding of at least two basic early writers, each English major is required to take either Engl 329 or 330, Shakespeare and Elizabethan Drama, and either Engl 327, Chaucer, or Engl 331, Milton. In addition to these five courses, each English major elects five additional courses, in either English or American literature, at least two of which are in literature before 1900, and at least three of which are numbered above 300.

It should be emphasized that thirty is the minimum number of hours for the major; many English majors will elect to take more. Each English major will have a departmental adviser to assist in selecting courses for the major program.

The department of English strongly recommends that any student contemplating the possibility of advanced study of English or American literature or of becoming a teacher of English should work toward departmental honors.

In order to receive departmental honors the English major attains a 3.50 grade average in courses presented for the major and must complete 39 hours of course work in English. Fifteen of these hours (five courses) are those required for the regular English major: Engl 23, 25 and 26, Engl 329 or 330, and Engl 327 or 331. Twelve hours (four courses) should be chosen from among the department's advanced period courses (Engl 360, 362, 364, 367, 369, 371, 376, 377, 378, 379, 380, 385 and 386), at least two of which must be in literature before 1900; three hours (Engl 181) are in the form of a thesis of substantial length (normally 25 to 50 pages).

The department of English also recommends that students working for departmental honors elect Engl 148, Introduction to the English Language, that they develop a competency in at least one foreign language, and that they

consider petitioning in their senior year to take one of the department's graduate seminars at the 400 level. Students who complete the courses required for departmental honors but who do not achieve the necessary grade average will receive the bachelor of arts degree with a major in English.

Minor in English

The department of English offers two minors, each requiring fifteen hours of course work beyond freshman English. To have entered on the transcript a minor in English, a student must take Engl 25 and 26, Survey of British Literature, and an additional nine hours in literature, at least six of them in British literature at the 300 level.

To have entered on the transcript a minor in American Literature, a student must take Engl 23 and 24, Survey of American Literature, and an additional nine hours in literature, at least six of them in American literature at the 300 level. The student's major adviser monitors the minor program. Either the student or the major adviser may consult with the department if there is question about which courses are acceptable for credit toward a minor.

Graduate work in English

The objective of the graduate program in English is not simply to impart knowledge, however wide or deep, but also to instruct the student in the methods of pursuing advanced study of literature and to provide training in the techniques of criticism and research.

A primary aim of the program is to furnish course work and individual instruction suitable for teachers of English at the secondary and college levels. Advanced degrees may be obtained in all areas of English and American literature. In 1975-76 about ninety candidates were enrolled in the graduate programs in English.

Students who wish to enter the graduate program in English should have an undergraduate major in English with at least fifteen semester hours of advanced courses in English literature. Students who did not major in English may be admitted, but will be expected to make up deficiencies in their undergraduate training in English in addition to satisfying other minimum requirements for the graduate degree sought.

Candidates for the master's degree in English who expect to continue for the doctor of philosopy degree are required to complete successfully twenty-four semester hours of coursework and to write a thesis representing the equivalent of six hours of course work. Master's degree candidates who do not wish to continue for the Ph.D. may, as an alternative, complete successfully twenty-seven hours of course work and pass an examination, preparation for which represents the equivalent of three hours of course work (see Engl 495 below). Details concerning the examination are available from the director of graduate studies in English.

Candidates for the master's degree whose needs and interests make it desirable may substitute up to six hours of collateral work in other departments. Master's candidates must take at least half of their required courses in 400-level seminars, but may select the balance of their curriculum from a variety of 300-level course offerings. Normally, at least six hours of course work for the master's degree must be in literature before 1660.

Candidates for the doctor's degree are accepted only after a consultation among the graduate professors in the department concerning the candidate's qualifications. Each candidate is required to take Engl 423, Old English, and either Engl 421, History of the English Language, or Engl 424, Beowulf.

The foreign language requirement for the Ph.D. (usually in Latin, French or German) may be satisfied in one of two ways: 1. the demonstration, through examination, of a reading knowledge of two foreign languages; or 2. the successful completion, concurrent with the graduate program, of a foreign language course, to be approved by the departmental director of graduate studies, at the 200, 300, or 400 level (or at a lower level in classical languages). This second option may also be used to satisfy the graduate school requirement that doctoral candidates take one course outside of the major department.

For the doctoral examination each candidate selects the following to be examined upon:

1. One of the following traditional periods: Old English and Medieval; Renaissance and Jacobean, 1500-1660; Restoration and Eighteenth Century, 1660-1798; Romantic and Victorian, 1798-1900; American Literature, Colonial-1899; Modern British and American Literature, 1900-present.

2. A major figure, to be selected in consultation with the chairman of the doctoral committee and subject to the approval of the departmental graduate committee.

3. A genre, theme, matter, or customary grouping, to be selected in consultation with the chairman of the doctoral committee and subject to the approval of the departmental graduate committee.

In each of the three areas of the examination the candidate is expected to demonstrate the knowledge and expertise that would be necessary to teach a course in the subject. The three areas may not overlap except for, in rare instances, the third.

Freshman courses

With the two exceptions noted below, all undergraduate students must take six hours of freshman English courses: Engl 1 and one of the four options for the second semester, Engl 2, 10, 14 or 16. The exceptions are:

1. Students with advanced placement or high verbal aptitude. Advanced placement and six semester hours of Lehigh credit for freshman English are given to students who earn scores of 3 or higher on the CEEB Advanced Placement Test in English. Similar credit is given to students who earn a score of 700 or higher on the SAT Verbal Aptitude Test. Such students need not take the regular freshman English courses (Engl 1, and 2, 10, 14 or 16), but they are encouraged to elect Engl 11 and 12. These are seminars designed to give to advanced freshmen practice in reading literature and in writing at the college level.

2. Undergraduate foreign students. Foreign students are students in the United States on non-immigrant visas.

Foreign students for whom English is not the native language are expected to have a level of proficiency in both oral and written English that will enable them to function adequately in their chosen curricula. All matriculating undergraduate foreign students whose native language is not English are required to take an English proficiency examination administered by the department. Those whose level of competence is judged to be adequate will receive six hours of credit in English. Those whose level of competence is inadequate will be required to enroll in Engl 3, English as a Second Language, until they achieve the necessary level; at that time they will receive six hours of credit in English. The requirement is a competency requirement. No credit hours are given for the course; no grade is given in the course.

Foreign undergraduate students for whom English is the native language are treated as American students. Undergraduate students on immigrant visas and citizens of the United States, either by birth or by naturalization, for whom English is not the first language may petition to replace the regular freshman English requirement with the requirement for foreign students. Students who wish to be considered for this option should consult the department.

Courses in English

1. Composition and Literature (3)
The art of expository writing. Appropriate collateral reading.

2. Composition and Literature: Fiction, Drama, Poetry (3)
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of drama, short fiction, and verse. Prerequisite: Engl 1.

3. English as a Second Language (0)
Oral and written English for non-native speakers. No grades are given. When students achieve the required level they receive six hours of credit in English.

10. Composition and Literature: Short Fiction (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of short stories and novellas. Prerequisite: Engl 1.

11. Literature Seminar for Freshmen (3) fall
Discussion of and writing about selected masterworks of literature. Open as elective to any freshman exempt from the regular freshman English requirement.

12. Literature Seminar for Freshmen (3) spring
Discussion of and writing about selected masterworks of literature. Open as an elective to any freshman exempt from the regular freshman English requirement. Upon recommendation of the Engl 1 instructor, a freshman who has earned a grade of A may complete the freshman English requirement by taking this course instead of Engl 2, 10, 14 or 16.

14. Composition and Literature: The Novel (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of selected novels. Prerequisite: Engl 1.

16. Composition and Literature: Drama (3) spring
Continuation of Engl 1. Further practice in expository writing in conjunction with the study of literary and theatrical aspects of several classic and contemporary plays. Prerequisite: Engl 1.

Basic undergraduate courses

The following courses are open to any student who has completed, or who has been exempted from, the required six hours of freshman English. Students may roster one of the following as a second English course to be taken concurrently with Engl 2, 10, 14 or 16, if they have earned a grade of B or above in Engl 1 and if they obtain the consent of the instructor in the second course. The letters UP indicate that the course meets both preliminary and upperclass distribution requirements for students in the College of Arts and Science.

23. Survey of American Literature (3) UP fall
Significant American writing from the settlement through the middle of the 19th century. Prerequisite: six hours of freshman English.

24. Survey of American Literature (3) UP spring
American literature from the middle of the 19th century to the present. Prerequisite: six hours of freshman English.

25. Survey of British Literature (3) UP fall
British literature from *Beowulf* through the pre-Romantics. Prerequisite: six hours of freshman English.

26. Survey of British Literature (3) UP spring
British literature from Wordsworth to Auden. Prerequisite: six hours of freshman English.

27. Chaucer's Canterbury Tales (2) UP fall, 1978
Chaucer's *Canterbury Tales*. Meets with Engl 327, but has a reduced reading and written assignment load. Prerequisite: six hours of freshman English. Mr. Beidler.

29. Shakespeare and Elizabethan Drama (3) UP fall
Selected plays, primarily by Shakespeare. Meets with Engl 329, but has a reduced reading and written assignment load. Prerequisite: six hours of freshman English. Mr. Hook, Ms. Traister.

30. Shakespeare and Elizabethan Drama (3) UP spring
Continuation of Engl 29. Meets with Engl 330, but has a reduced reading and written assignment load. Prerequisite: six hours of freshman English. Mr. Hook, Ms. Traister.

51. The Drama (3) UP fall
Selected plays; theories of drama; drama and the stage; drama as a criticism of life. Prerequisite: six hours of freshman English.

52. The Drama (3) UP spring
Continuation of Engl 51. Prerequisite: six hours of freshman English.

53. The Short Story (3) UP
English, American and Continental short story. Class discussions, collateral reading, and reports. Prerequisite: six hours of freshman English.

55. The Novel (3) UP fall
Selected novels as works of literature. Prerequisite: six hours of freshman English.

56. The Novel (3) UP spring
Continuation of Engl 55. Prerequisite: six hours of freshman English.

57. Poetry (3) UP fall, 1978
Traditional and modern poetry read for pleasure and understanding. Prerequisite: six hours of freshman English.

59. Masterpieces of World Literature (3) UP fall, 1977
Great works from the literature of epic poetry, drama, romance, and essay which illustrate the humanistic traditions of Western civilization. Prerequisite: six hours of freshman English.

63. Narrative Cinema (1)
Major historical periods and the major aesthetic innovations of narrative fictional cinema of Europe and the United States. Meets once a week for showing of a film, lecture and discussion. Prerequisite: six hours of freshman English. Mr. MacDonald.

71. Expository Writing Workshop (1-3) UP
Practice in and criticism of expository writing beyond the freshman level. Title may vary: The Technical Report; The Informal Essay; Review of Grammar; etc. May be repeated for credit. Prerequisite: six hours of freshman English.

73. Creative Writing Workshop (1-3) UP
Practice in and classroom criticism of creative writing done by students taking the course. Title may vary: Short Story; Drama; Poetry; etc. May be repeated for credit. Prerequisite: six hours of freshman English.

75. Individual Authors (1-3) UP
Intensive study of the works of one or more literary artists. Title will vary: Emily Dickinson; Swift and Jefferson; Yeats, O'Casey, and Joyce; etc. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

77. Individual Works (1-3) UP
Intensive study of one or more literary works. Title will vary: *Moby-Dick;* Medieval Mystery Plays; *Morte Darthur, Idylls of the King,* and *The Once and Future King;* etc. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

79. Character Types in Literature (1-3) UP
Study of a character type in several works of literature by several authors. Title will vary: The Mad Scientist in Drama and Fiction; The Devil in Literature; The Lawyer in Modern Literature; etc. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

81. Themes in Literature (1-3) UP
Study of a recurring theme as it appears in several works of literature. Title will vary: Pastoralism; Utopias in Literature; The Oedipus Complex in Literature before and after Freud; etc. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

83. Popular Literature (1-3) UP
A form of literature which is or has been of interest primarily to a "popular" audience. Title will vary: Folklore; Detective Fiction; The Western Novel; etc. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

85. Performing Literature (1-3) UP
Study of and practice in literature to be performed before an audience. Title will vary: Literature Aloud; Opera as Literature; etc. May be repeated for credit as title varies. Prerequisite: six hours of freshman English.

89. Science Fiction (3) UP
The genre with emphasis on its role as creator and reflector of attitudes toward scientific and technological advances. Prerequisite: six hours of freshman English. Mr. Gallagher, Ms. Arbur.

91. Special Topics in English (1-3) UP
A characteristic topic or genre or approach in literature not covered in other courses. Prerequisite: six hours of freshman English.

Undergraduate courses

The following courses are more advanced than the courses which appear in the preceding list, but they are by no means designed exclusively for specialized students. Each course is a self-contained unit and has no prerequisites beyond the two semesters of freshman English.

The purpose of most of the courses listed below is to acquaint students from all segments of the university with the best that has been written through the ages by the most effective literary artists. These courses may be used to fulfill preliminary or upperclass distribution requirements for students in the College of Arts and Science.

148. Introduction to the English Language (3) spring, 1978
Basic linguistic concepts together with a historical survey of the English language. Mr. Vickrey.

150. (Phil 150) Media and Values (3) fall, 1977
How media and values are formed and reformed by their mutual interaction. Combines humanistic criticism with philosophical analysis of the principal media (the human body, language, film, television, architecture, art) through which human values arise and take their place in the world. Historical, existentialist, phenomenological and structuralist analyses. Individual student projects in media-value analysis or manipulation. Messrs. MacDonald and Haynes.

181. Undergraduate Thesis (3)
Open to advanced undergraduates who wish to submit theses in English. Prerequisite: consent of the department chairman.

183. Readings in English and American Literature (3)
Open to advanced students who wish to pursue special or independent courses of reading in literary study. Prerequisite: consent of department chairman.

263. Aesthetics of Cinema (3) spring, 1977
Aesthetics of silent and sound cinema, with an emphasis on the major theorists (Munsterberg, Eisenstein, Bazin, etc.) and the literary, linguistic, and semiological criticism of Agee, Warshow, de Sassure, Jakobson, Levi-Strauss, Barthes, Metz, et al. Extensive reading and writing relating to these topics. Prerequisite: FA 5 and Engl 63 previously or concurrently, or consent of department chairman. Mr. MacDonald.

300. Apprentice Teaching (3)
Supervised participation in various aspects of

Fig. 874. — DRINKING WASSAIL.
(From a rare print by Josias English, 1656.)

the teaching of a course. Prerequisite: consent of department chairman.

301. Topics in Literature (1-3)
A theme, topic, or genre in literature. Title will vary: Contemporary Drama; Autobiography as Literature; Literary Censorship; etc. May be repeated for credit as title varies.

311. Literature of Women (3) fall, 1978
Literature by and about women, including both acclaimed and little-known works. Open inquiry into gender-identification of the literary imagination. Ms. Arbur.

312. Jewish Literature (3) spring, 1978
Development of Jewish literature (including Yiddish literature in translation) from Russian and Eastern European beginnings to immigration and assimilation in America. Ms. Fifer.

316. The Indian in American Literature (3) spring, 1977
The American Indian as portrayed in folklore, poetry, and fiction in America. Works written by both Indian and non-Indian writers will be discussed. Mr. Beidler.

319. The Black in American Literature (3) fall, 1977
Black characters and the literary treatment of the black experience in American fiction and drama from 1850 to the present. Comparative examination of both black and non-black authors, such as W.W. Brown, Stowe, Melville, Twain, Chesnutt, Hughes, Toomer, Faulkner, Wright, Baldwin, Ellison, Styron and Baraka. Mr. Frakes.

327. Chaucer (3) fall, 1978
The chief works of Geoffrey Chaucer, with attention to his language and the backgrounds of his works. Mr. Beidler.

328. Shakespeare Laboratory (0-1)
Selected plays as scripts for theatrical production. Scheduled concurrently with Engl 329 or 330. Students who desire to use this course as an alternative to papers and examinations in Engl 329 or 330 should roster 0 credit hours. Mr. Hook, Ms. Traister.

329. Shakespeare and Elizabethan Drama (3) fall
Development of the English drama, including the important plays of Shakespeare. Mr. Hook, Ms. Traister.

330. Shakespeare and Elizabethan Drama (3) spring
Continuation of Engl 329. Mr. Hook, Ms. Traister.

331. Milton (3) fall, 1977
Life and works of John Milton in connection with the history of his times and the chief sources of his inspiration. Mr. Greene.

360. Middle English Literature (3) spring, 1979
Major literary works of the Middle English period by authors other than Chaucer; some works in translation, some in the original. Emphasis on Langland, Gower, the Pearl Poet, and the metrical romances. Mr. Hartung.

362. The Renaissance (3) spring, 1980
English nondramatic literature in the 16th century and the stimulus of the Italian Renaissance and northern humanism. Readings in and class discussions of the works of the chief writers—Petrarch, Erasmus, More, Wyatt, Surrey, Lyly, Sidney and Spenser. Mr. Greene.

364. The Seventeenth Century (3) spring, 1978
English literature of the 17th century, from Donne to Dryden: Donne and the "Metaphysical School"; Jonson and "The Tribe of Ben"; Cavalier and religious poetry; the prose of Bacon, Browne, Burton, Walton and Bunyan. Ms. Traister.

367. The Eighteenth Century (3) fall, 1979
Great British writers of the 18th century, beginning with the Restoration. Particular attention paid to Dryden, Pope, Swift, Defoe, Fielding and Jonson and his circle. Mr. James.

369. English Literature of the Romantic Era (3) fall, 1978
Poetry and prose of the chief romantic writers—Wordsworth, Coleridge, Scott, Byron, Shelley, Keats, Lamb, Hazlitt, De Quincy. Consideration of the contemporary political, religious and social problems exhibited in the literature. Readings and class discussion. Mr. Harson.

371. English Literature of the Victorian Era (3) fall, 1977
Poetry and prose of the chief Victorian writers—Tennyson, Browning, Arnold, Clough, Rossetti, Morris, Swinburne, Macaulay, Carlyle, Mill, Newman, Ruskin. Consideration of the contemporary political, religious, and social problems exhibited in the literature. Readings and class discussion. Mr. Bross.

376. Early American Literature (3) spring, 1980
American literature to the Romantic period. Mr. Gallagher.

377. American Romanticism (3) fall, 1977
The chief American Romantics—Emerson, Thoreau, Whitman, Hawthorne, Melville and Dickinson. The European and American philosophical, historical, and social background as well as the formal aesthetic study of romantic masterpieces. Ms. Arbur, Mr. De Bellis.

378. American Realism (3) spring, 1979
Theory and practice of realistic fiction from the Civil War to the early 20th century: Twain, Howells, James, Norris, Crane, Chopin, Dreiser, and others. Mr. Frakes.

379. Twentieth-Century American Literature (3) fall, 1978
American literature before World War II. Lectures and class discussion of major fiction and poetry. Mr. De Bellis. Ms. Mundhenk.

380. Contemporary American Literature (3) spring, 1978
American literature since World War II. Lectures and class discussions of new writers and of recent works of established writers. Mr. De Bellis. Mr. Frakes.

382. Themes in American Literature (3) spring
Intensive study of one topic in American literature. Readings from the colonial period to the present. Sample topics: The American Rediscovery of Europe; The Theme of Apocalypse; American Humor; The Edenic Motif; Personal Revolt and Social Protest. May be repeated for credit as topic varies. Mr. Frakes.

383. Experimental Literature: Form, Space, Time (3) fall, 1978
Innovative literature. The literary work as "model"; structure, point of view, style, and technique as meaning. Kafka, Joyce, Borges, Robbe-Grillet, Woolf, Faulkner, Stein, Hawkes, Beckett, Pynchon, Barthelme, and others. Mr. Frakes.

385. Twentieth-Century World Literature (3) fall, 1977
World English literature and continental literature before World War II. Lectures and class discussion of major fiction and poetry. Mr. Bross.

386. Contemporary World Literature (3) spring, 1979
World English literature and continental literature since World War II. Lectures and class discussions of new writers and of recent works by established writers. Mr. Frakes.

Graduate courses

The following courses are seminars, ordinarily limited to no more than twelve graduate students, but undergraduate English majors who are planning to go on to graduate school in English and who have shown proficiency in the study of literature may petition to take one of these seminars in their senior year. The professors listed are the ones most likely to teach seminars in the areas listed. The courses are offered at varying intervals.

421. History of the English Language (3)
The phonology, grammar and lexicon of English from the beginnings to the present. Mr. Vickrey.

423. Old English (3)
Old English language and literature. Mr. Vickrey.

424. Beowulf (3)
The Beowulf poem and some of the pertinent scholarship. Mr. Vickrey.

427. Chaucer (3)
The life and works of Chaucer. Readings, reports and discussions. Mr. Hartung.

428. Chaucer (3)
Continuation of Engl 427. Mr. Hartung.

429. Middle English Metrical Romances (3)
Middle English non-Arthurian verse romances. Mr. Hartung.

431. Arthurian Literature of the Middle Ages (3)
Arthurian literature from its Celtic beginnings to Malory's *Morte Darthur*. Mr. Hartung.

433. Middle English Literature (1-3)
A topic, a genre, or a grouping of works or authors in the Middle English period. Sample offerings: The Medieval Humorous Tale; Medieval Drama. May be repeated for credit as title varies. Mr. Beidler.

439. Sixteenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the 16th century. Sample offerings: 16th-Century Drama; Spenser. May be repeated for credit as title varies. Mr. Hook, Ms. Traister.

441. Seventeenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the 17th century. Sample offerings: Jacobean and Caroline Drama; Metaphysical Poetry. May be repeated for credit as title varies. Mr. Hook, Ms. Traister.

443. Eighteenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the 18th century. Sample offerings: Augustan Satire; The Rise of the Novel. May be repeated for credit as title varies. Mr. James, Ms. Fergus.

445. Nineteenth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in the Romantic or Victorian periods. Sample offerings: Tennyson and Browning; Wordsworth and Byron; The Victorian Novel. May be repeated for credit as title varies. Mr. Bross, Mr. Harson, Ms. Mundhenk.

449. Twentieth-Century British Literature (3)
A topic, a genre, or a grouping of works or authors in 20th-century literature of the British Isles. Sample offerings: Conrad; Joyce. May be repeated for credit as title varies. Mr. Greene, Mr. Frakes.

471. Early American Literature (3)
A topic, a genre, or a grouping of works or authors of colonial America or the early republic. Sample offerings: The Roots of the American Dream; Science and Religion in the Colonial Period. May be repeated for credit as title varies. Mr. Gallagher.

473. American Romanticism (3)
A topic, a genre, or a grouping of works or authors in the American Romantic period. Sample offerings: The Nature of Evil in Hawthorne, Melville, and Poe; Hawthorne's and Melville's Narrators. May be repeated for credit as title varies. Ms. Arbur, Mr. De Bellis.

475. American Realism (3)
A topic, a genre, or a grouping of works or authors in American literature from the Civil War to World War I. Sample offerings: James; American Literary Naturalism. May be repeated for credit as title varies. Mr. Frakes.

477. Modern American Literature (3)
A topic, a genre, or a grouping of works or authors in the literature written after World War I. Sample offerings: Hemingway and Faulkner; The Apocalyptic Vision; Southern Writers; Modern American Poetry. May be repeated for credit as title varies. Mr. De Bellis, Mr. Frakes.

481. Literary Criticism (3)
Theory and practice of criticism. The nature and function of literature itself, the assumptions and methodologies of major 20th-century critical "schools," and similar topics, regarded as objects of knowledge and as models for students' own critical reading, writing, and teaching. May be repeated for credit as topic varies. Ms. Arbur.

485. Teaching of College English (3)
History, theory, and practice of teaching the freshman composition course. Required of all new teaching assistants in the department of English. May be rostered by others only with consent of the department chairman. Ms. Mundhenk.

489. Workshop for English Teachers (1-3)
Study of a body of information with particular emphasis, through reports and discussion, on how the information can best be taught to secondary and college students. Sample topics:

Fig. 200. — ARTEMISIA ABSINTHIUM. (Wormwood.)

Shakespeare for Teachers; Teaching the American Literature Survey; Teaching the British Literature Survey. May be repeated for credit as topic varies.

491. Special Topics (1-3)
Selected topics in the field of English not covered in other courses. May be repeated for credit as topic varies.

493. Graduate Seminar (3)
Intensive study of the works of one or more authors, or of a type of literature, or of the teaching of an author or a type of literature. May be repeated for credit as topic varies.

495. Independent Study (3)
Independent study in approved areas. To be rostered by candidates for the master of arts degree in English who desire to take an examination on selected figures rather than submit a thesis. Prerequisite: consent of department chairman.

JOURNALISM

Professors. Joseph B. McFadden, M.A., head; Robert J. Sullivan, M.A.

Assistant professor. Sharon M. Friedman, M.A.

Journalism is concerned with the exercise of social responsibility in human affairs. The profession of journalism deals with the truthful communication of facts and their explanation. It is the purpose of the program in journalism to bring its majors: 1. to the point where they can gather significant information, organize it quickly into effective form, and communicate it clearly, accurately, and with a disciplined objectivity; and 2. to an understanding of the legitimate role of the press in society.

The first of these objectives is obtained by extensive, professionally oriented practice in the writing, reporting, and editing of news. The skill thus acquired is firmly rooted in rigorous training in vocabulary, in precision of expression, and in sophistication in style. It is concerned with clear writing and careful reporting, the kind that depicts the meaning of events. It develops from a purposeful curiosity and a capacity to be imaginatively interested in human activity. The second objective is obtained: 1. by study of the rights and responsibilities of the press under the Constitution, with emphasis upon the freedom of the press as conditioned by the liberties of the individual and the needs of society; 2. by examination of the journalistic tradition in the United States in relation to the political, economic, scientific, and social progress of the population; and 3. by independent study, culminating in an undergraduate thesis, of the press and society.

The basic program in journalism provides opportunity for concentration in at least one of the following areas: American studies, business management, economics, government, history, international relations, languages, literature, philosophy, religion studies, science, social relations, and urban studies.

A second option for those wishing to major in journalism is to concentrate in science writing. Those selecting this major will learn to write about pure and applied scientific research, technology and engineering, medicine, and the environment. A minor in science writing also is available for those who wish to major in another field such as science or engineering but become skilled in science communication techniques.

For persons interested in environmental writing, a bachelor of science degree in Environmental Sciences and Resource Management (ESRM) with a concentration in environmental science writing is offered through the ESRM interdisciplinary program in cooperation with the division of journalism. Students are required to take a core sequence of 66 credits in preliminary science courses and 18 credits in the science writing program, plus electives. For details refer to the ESRM program description on page 116.

Although the great majority of graduates in journalism enter some phase of written communication as a career—daily newspaper, wire services, magazine, public or industrial relations, advertising, technical writing—others have used their background in journalism as a basis for the study and practice of law, service in government, teaching, business management, and graduate study in a variety of disciplines.

Those concentrating in science writing can expect to pursue careers in science journalism with either general or specialized publications; in public information or public relations for scientific societies, government agencies, universities, industries, hospitals, etc.; in technical writing; or in related areas in which science communication skills are highly desired such as management, teaching, and administration. The program also prepares students for graduate study in science writing, general journalism and a number of other disciplines.

Basic journalism major

required preliminary courses

Journ 1, 2	Brown and White (2)
Journ 11	News Writing (3)

required major courses

Journ 3-8	Brown and White (2-6)
Journ 17	Magazine Article Writing (3)
Journ 113	Editing (3)
Journ 114	Reporting of Public Affairs (3)
Journ 115	Interpretive Writing (3)
Journ 120	Journalism Proseminar (3)
Journ 121, 122	Law of the Press (6)

Note: *Brown and White* must be rostered each semester while the student is a journalism major, and a minimum of four such semesters is required. With the approval of the journalism faculty, current professional newspaper experience may be substituted semester for semester.

Dual majors and recommended electives
Journalism majors are encouraged to declare dual majors in journalism and another field, such as one of those discussed under concentrations above. In-depth knowledge of a specialty area is considered an asset to a journalism career. Those not desiring to declare a dual major should consider either declaring a minor in one of these fields or concentrating their elective courses in one or two of these areas. Dual majors, minors and concentration areas should be chosen in consultation with the major adviser.

Journalism major/science writing

required major courses

Journ 1-8	Brown and White (1-8)
Journ 11	News Writing (3) or
Journ 123	Basic Science Writing (3)
Journ 113	Editing (3)
Journ 114	Reporting of Public Affairs (3)
Journ 122	Law of the Press II (3)
Journ 124	Politics of Science (3)
Journ 125	Environment, the Public and the Mass Media (3)
Journ 126	Writing About the Environment (3)
Journ 313	Special Topics in Science Writing (3)

Note: Those concentrating in science writing must roster *Brown and White* each semester after declaring the major. A minimum of four such semesters is required. Current professional newspaper or magazine experience may be substituted semester by semester.

required science courses
A minimum of 24 credits in the physical, biological, environmental or social sciences or engineering is required. These hours can be concentrated in any one area or distributed among all five areas, although an area concentration is recommended. Dual majors in journalism/science writing and a science are encouraged. Science courses should be chosen in consultation with the major adviser.

Journalism minor

Students who wish to declare a minor program in journalism must be majors in another discipline and take the following courses:

Journ 1-3	Brown and White (3)
Journ 11	News Writing (3)
Journ 113	Editing (3)
Journ 115	Interpretive Writing (3)
Journ 122	Law of the Press II (3)

Fifteen credits are required.

Science writing minor

Students desiring to minor in journalism/science writing should be majors in another discipline, preferably a science. The following courses are required:

Journ 1-2	Brown and White (2)
Journ 11	News Writing (3) or
Journ 123	Basic Science Writing (3)
Journ 124	Politics of Science (3)
Journ 125	Environment, the Public and the Mass Media (3)
Journ 126	Writing About the Environment (3)
Journ 312	Advanced Science Writing (3) or
Journ 313	Special Topics in Science Writing (3)

Seventeen credits are required.

Journalism courses

Media internships

With the approval of the journalism faculty, qualified students may acquire professional experience in internships with area newspapers and magazines.

1-10. Brown and White (1-2)
Enrollment constitutes membership on the staff of the semiweekly paper. Students enrolling for their first semester register for Journ 1; for their second semester, Journ 2, etc. Prerequisite: consent of division head.

1. News Writing (3)
Definition, determinants, and components of news; news story structure and style; sources; interviewing; practice in gathering and writing news. Offered each semester. Mr. Sullivan and Ms. Friedman.

17. Magazine Article Writing (3) fall
Writing and marketing nonfiction magazine articles. Mr. McFadden.

21. Creative Writing (3)
The study and writing of fiction, short stories, especially with a view to developing each student's particular talent. Prerequisite: consent of division head and Engl 2, 10, 14 or 16. Mr. McFadden.

22. Creative Writing (3)
Continuation of Journ 21. Prerequisite: consent of division head and Engl 2, 10, 14 or 16. Mr. McFadden.

111. Problems in Advanced Reportage (3)
Intensive practice in the reporting of complex events.

112. Problems in Advanced Reportage (3)
Continuation of Journ 111.

113. Editing (3) fall
Study of and practice in newspaper desk work: headline writing, makeup, and typography; selecting, editing and rewriting news and feature copy; use of reference works and newspaper libraries. Prerequisite: Journ 11. Mr. Sullivan.

114. Reporting of Public Affairs (3) spring
Reporting and writing news of government on the local, county, state and federal levels; civil and criminal courts; labor, environment, housing and community planning news. Prerequisite: Journ 11. Ms. Friedman.

115. Interpretive Writing (3) spring
Editorial interpretation of current events; practice in interpretive writing, including editorials. Prerequisite: Journ 11. Mr. Sullivan.

118. History of American Journalism (3)
English background of the American newspaper; development of press from Colonial days to the present; influence of newspapers on American life; contributions of outstanding journalists. Ms. Friedman.

120. Journalism Proseminar (3) fall
Survey of the press in its relation to public affairs. Extensive research and reports. Prerequisite: consent of division head. Mr. McFadden.

121. Law of the Press (3)
Constitutional development of freedom of the press; rights and responsibilities of the press. Mr. McFadden.

122. Law of the Press II (3) spring
Law of and defenses in libel; privacy; contempt; copyright; obscenity. Mr. McFadden.

123. Basic Science Writing (3) fall
Writing news and feature articles on scientific and technological subjects for the mass and specialized media. Prerequisite: six hours of science or consent of division head. Ms. Friedman.

124. Politics of Science (3) spring
Organization of the U.S. scientific community and how it interacts with government, the mass media and the public. Ms. Friedman.

125. Environment, the Public and the Mass Media (3) fall
Public perceptions of environmental problems and of roles played by business, government, the mass media and environmental groups. Analysis of techniques of persuasion, with student investigations of regional environmental problems. Ms. Friedman.

126. Writing About the Environment (3) spring
Practice in techniques of environmental public relations, including press releases, public service announcements, newsletters, reports and pamphlets. Environmental persuasion campaigns for actual clients. Prerequisite: Journ 125 and either Journ 11 or Journ 123, or consent of division head. Ms. Friedman.

311. Science Writing (3) fall
Study of and practice in writing about science and technology for general print, electronic media and specialized science publications. Includes news and feature articles, report writing and analysis of factors that influence science communication to the public. Emphasis on writing and organizational skills and translation of scientific material into lay language. Should be taken by upperclass and graduate students instead of Journ 123. Prerequisite: six hours of science or consent of division head. Ms. Friedman.

312. Advanced Science Writing (3)
Continuation of Journ 123 or Journ 311. Prerequisite: Journ 123 or Journ 311. Ms. Friedman.

313. Special Topics in Science Writing (3)
Interpretive feature writing on controversial or complex scientific and technological topics. Emphasis on in-depth investigations, interviewing, and balanced reporting. Prerequisite: Journ 11, or Journ 123, or Journ 311, or consent of division head. Ms. Friedman.

SPEECH AND DRAMA

Professor. Frank S. Hook, Ph.D.
Associate professor. Thoburn V. Barker, M.A.
Assistant professors. James Hill, M.F.A.; Jeffrey Milet, M.F.A., head.
Instructors. Ann Roth, B.F.A.; Jessica Woods, B.F.A.

Drama as a form of expression has been characterized as bordering many areas of knowledge. It is an art with spiritual and social vision. It celebrates, for participant and spectator, the phenomenon of communication and interaction.

The division of speech and drama provides training and practice in using the implements of drava in a variety of communicative situations. Students probe the aesthetics of theatre; they investigate drama as a means of disseminating information; they find the bond between drama and the community.

The bachelor of arts in drama is given after a program of study including the traditional skills of the theatre: acting, directing, playwriting, design, lighting, movement and production. During instruction, students are encouraged to take part in the productions. Students work with faculty and visiting professionals in preparing productions in the Wilbur Drama Workshop.

The major in drama requires a minimum of thirty hours of course credit. In order to enjoy broader opportunities for the application of their theatrical skills, students are encouraged to consider interdisciplinary and double majors. A minor is also offered.

Graduates with backgrounds in drama are prepared for graduate work (in master of arts or master of fine arts programs) or for professional apprenticeship programs. The drama program also attempts to prepare students to apply their talents and training to a wide variety of related or associated fields.

The Mustard and Cheese Drama Organization offers the student opportunities to participate in extracurricular drama activities.

Drama major

Core courses required of all majors

Drama 15	Introduction to Technical Theatre (3)
Drama 41	Beginning Acting (3)
Drama 71	Introduction to Theatre History (3)
Drama 144	Basic Directing (3)

Option I
acting/directing
required courses

Drama 16 or 18	Introduction to Lighting or Scene Design (3)
Drama 42	Acting II (3)
Speech 241	Phonetics (3)
Drama 341	Acting III (3)
Drama 343	Movement for the Stage (3)
Drama 361	Advanced Directing (3)

Option II
design/technical theatre
required courses

Drama 16	Introduction to Lighting (3)
Drama 18	Introduction to Scene Design (3)
Drama 96	Basic Costume Design (3)
Drama 116	Advanced Technical Theatre (3)
Drama 117	Advanced Lighting (3)
Drama 118	Advanced Scene Design (3)

Drama minors

Acting/directing

Dr 15	Introduction to Technical Theatre (3)
Dr 41	Beginning Acting (3)
Dr 71	Introduction to Theatre History (3)
Dr 144	Basic Directing (3)

plus one upper division Drama elective

Technical theatre

Dr 15 Introduction to Technical Theatre (3)
Dr 16 Introduction to Lighting (3)
Dr 18 Introduction to Scene Design (3)
and two of the following
Dr 116 Advanced Technical Theatre (3)
Dr 117 Advanced Lighting (3)
Dr 118 Advanced Scene Design (3)
Dr 119 Special Technical Studies (3)

Undergraduate courses

Drama 1. Introduction to Theatre (3) UP
Theatre concepts for the intelligent playgoer: significance of theatrical space, visual and aural effects; the actor at work; role of director and designer; what goes on backstage. Students observe rehearsals and performances of plays produced by the division of drama. Course may not be included in either the major or minor in drama.

Drama 11-13. Basic Production (1)
Practical experience in all forms of theatre art. Students enrolling for their first semester register for Drama 11; for their second semester, Drama 12, etc.

Drama 15. Introduction to Technical Theatre (3) UP
Stagecraft, scenery construction, and drafting for the theatre.

Drama 16. Introduction to Lighting (3)
The development of stage lighting, its tools and concepts. Prerequisite: Drama 11, 15, or consent of division head.

Drama 18. Introduction to Scene Design (3) UP
The tools and concepts used by the theatrical designer. Prerequisite: Drama 11, 15, or consent of division head.

Speech 21-23. Impromptu Speaking (1)
The organization and presentation of short expository speeches and of speeches for special occasions. Content drawn from contemporary events. Students enrolling for their first semester register for Speech 21; for their second semester, Speech 22, etc. Prerequisite: consent of division head.

Speech 30. Fundamentals of Speech (3)
A foundation course designed to develop knowledge of the basic principles of speech and ability to communicate.

Speech 31. Business and Professional Speaking (3)
Development of speech for business and professional problems; technique of expository speaking; use of visual graphics; persuasive speaking applied to the emotional or analytical approach in selling; methods of interviewing; techniques of conference. Prerequisite: consent of division head.

Drama 41. Beginning Acting (3) UP
Techniques of the 20th-century actor. Vocal production, stage movement, improvisational acting, characterization. Some laboratory projects in special areas. Some scene study.

Drama 42. Acting II (3) UP
Continuation of Drama 41. Prerequisite: consent of division head or Drama 41.

Drama 43. Movement and Content (2) UP
Basic movement in its relationship to the spoken word and/or music.

Speech 47. Oral Interpretation (3)
The analysis and oral presentation of various types of literature. Consideration of sound values, rhythm and imagery. Prerequisite: consent of division head.

Drama 51. Special Projects (3)
Exploration of specialized areas of theatre practice. Prerequisite: consent of division head.

Drama 61. Theatre Production (3)
Practical technique and production. Classes present, under professional supervision, full-scale productions.

Drama 62. Theatre Production (3)
Continuation of Drama 61. May be taken three times for credit with consent of division head. Prerequisite: Drama 61.

Drama 71. Introduction to Theatre History (3) UP
Survey of history of theatre in the Western world from the Greeks to the 20th century.

Drama 85. Production Seminar (3) UP
Study and practice in literature to be performed before an audience.

Drama 96. Basic Costume Design (3) UP
Theatrical costuming; opportunity for supervising practice in design and execution of theatrical fashions.

Drama 116. Advanced Technical Theatre (3)
Advanced problems in stagecraft, scenery construction, and rigging. Materials for the theatre. Prerequisite: Drama 11, 12, 15 or consent of division head.

Drama 117. Advanced Lighting (3)
The art and practice of designing lighting for the theatre. Prerequisite: Drama 11, 12, 15, 16, 18 or consent of division head.

Drama 118. Advanced Scene Design (3)
Advanced problems in designing scenery for the stage. Prerequisite: Drama 11, 12, 15, 16, 18, or consent of division head.

Drama 119. Special Technical Studies (3)
Topics not covered by other courses. Prerequisite: consent of division head.

Drama 144. Basic Directing (3)
Survey of theatrical direction. Study of the emergence of the director. Prerequisite: consent of division head or Drama 41.

Drama 172. Special Studies in Theatre History (3)
Selected periods of theatre history. Students work independently on period of their own choice. Prerequisite: Drama 71.

Drama 173. Special Studies in Theatre History (3)
Continuation of Drama 172. Prerequisite: Drama 172.

Speech 241. Phonetics (3)
Practice in the use of the international phonetic alphabet. Consideration of the standard speech characteristics of the three major American regional dialects. Prerequisite: consent of division head.

Fig. 1523. — LASSOING.

Drama 341. Acting III (3)
Extension of Drama 41 and Acting II. Further study of the actor's techniques. Prerequisite: Drama 41 and Acting II or consent of division head.

Drama 342. Acting IV (3)
Continuation of Acting III. May be taken three times for credit. Prerequisite: Acting III or consent of division head.

Drama 343. Movement for the Stage (3)
Physical skills for actors: basic choreography, group movement and basic pantomime. Prerequisite: consent of division head.

Drama 351. Advanced Projects (3)
Exploration of specialized areas of theatre practice. Prerequisite: consent of division head.

Dramu 361. Advanced Directing (3)
Extension of Drama 144. Student analysis and formulation of a directorial approach, culminating in the production of a full-length play. Prerequisite: Drama 144 or consent of division head.

Drama 371. Playwriting and Criticism (3)
Study of the resources and techniques of the dramatist. Critical analysis of the playwright's creative process and practice in creating smaller dramatic forms. Prerequisite: Drama 41, 61, 144, or consent of division head.

Drama 381. Improvisational Acting (3)
Improvisational and group theatre techniques. Improvisational performance from Commedia to Viola Spolin to the newer improvisational forms.

Drama 383. Directing the Improvisational Ensemble (3)
The task of the ensemble guide in improvisational theatre of various kinds. Work with the experimental adult group as well as applications for creative dramatics and street theatre with children.

Fig. 1309. — BARLEY.
a, two-rowed barley; b, sprat or brattledore barley.

ENVIRONMENTAL SCIENCES AND RESOURCE MANAGEMENT

Edward B. Evenson, Ph.D., director of environmental sciences and resources management and assistant professor of geological sciences.

Society's increasing demands for energy, water, mineral commodities, food, recreational and living space have altered and will continue to alter the global ecosystem. The need for personnel trained to evaluate proposed alterations and repair existing deleterious or critical situations can best be met by an interdisciplinary approach. Additionally, there is a pressing need to communicate about environmental problems at all levels of society, from the scientist to the layman. Writing about the environment can best be done by persons trained in both science and communication skills.

Environmental sciences and resource management is an interdepartmental major fostering basic preparation for advanced study or an immediate career in environmental management, conservation and environmental science writing. The backgrounds of fundamental mathematics and science required to understand the interactions of humans and their environment are established early in the major where the student is exposed to the core courses of mathematics, chemistry, physics, biology and geology.

Following this basic preparation, students select a concentration area within which more advanced training is undertaken. Concentrations in biology, chemistry, geology and environmental science writing have been established and concentrations in other fields can be designed to meet the needs and career desires of individual students.

Student research in specific problems involving laboratory, field, library or mass media research is an integral part of the program and is strongly encouraged.

Graduates of this major can expect to take part in planning, education, research and coordination of environmental programs for all levels of government and industry. Those concentrating in environmental science writing also can pursue careers in science journalism or in professions such as environmental law or environmental management, where communication skills are highly desired. Graduate study is advisable for students wishing to pursue a career in most aspects of environmental science and the program provides thorough preparation for advanced training in environmental science or concentration areas.

bachelor of science degree

The program requires 120 credit hours. Credit is allocated as follows: 36 credits for college and university requirements, 66 credits in preliminary courses, and 18 credit hours in the area of concentration.

college and university requirements (36 credits)

Engl 1	Composition and Literature (3)
Engl 2, 10, 14, or 16	Composition and Literature (3)
	general electives (30)

Note: General elective courss are non-professional courses designed to give the student a broad understanding in traditional and contemporary fields of thought outside of natural science and mathematics. The courses are chosen by the student. The elective program shall include a number of courses broadly distributed among the various areas of the humanities and the social sciences.

required preliminary courses (66 credit hours)

Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)
Phys 11	Introductory Physics I (4)

Phys 12 Introductory Physics Lab I (1)
Phys 21 Introductory Physics II (4)
Phys 22 Introductory Physics Lab II (1)
Chem 21 Introductory Chemical Principles (4)
Chem 22 Chemical Principles Lab (1)
Chem 23 Analytical Environmental Chemistry (3)
Chem 51 Organic Chemistry (3)
Chem 53 Organic Chemistry Lab (1)
Geol 1 Principles of Geology or Geol 101 (3)
Geol 2 Introductory Geology Lab (1)
Geol 12 Historical Geology and Strat. (3)
Geol 33 Introductory Mineralogy and Petrology (3)
Geol 211 Environmental Geology (3)
Biol 21 Principles of Biology (3)
Biol 22 Introduction to Biology Lab (1)
Biol 35 Microbiology (3)
Biol 306 Ecology (3)
Biol 303 Invertebrate Zoology (3)
or or
Biol 331 Nonvascular Plants (3)
or or
Biol 332 Vascular Plants (3)
or or
Biol 34 Comparative Anatomy (3)
Eco 311 Environmental Economics (3)
CE 371 Environmental Health
or Engineering (3) or
Biol 361 Sanitary Microbiology (3)

Concentrations (18 credit hours)

Students select and fulfill one of the following concentration areas.

geology

Geol 23 Structural Geology (3)
Geol 312 Geomorphology (3)
Geol 313 Sedimentology (3)
Geol 333 Crystallography (3)
Geol 341 Field Camp (6)

biology

Biol 28 Genetics (3)
Biol 303 Invertebrate Zoology (3)
or or
Biol 331 Non-vascular Plants (3)
or or
Biol 332 Vascular Plants (3)
or or
Biol 34 Comparative Anatomy (3)
Biol 309 Aquatic Biology (3)
Biol 322 Animal Physiology (3)
Biol 317 Evolution (3)
Chem 52 Organic Chemistry (3)

chemistry

Chem 52 Organic Chemistry (3)
Chem 54 Organic Chemistry Lab (2)
Chem 187 Physical Chemistry (3)
Chem 191 Physical Chemistry (3)
Chem 234 Analytical Chemistry Lab (1)
Chem 334 Chemical Oceanography (3)
Chem 332 Analytical Chemistry (3)

environmental science writing

Journ 123 Basic Science Writing (3)
Journ 124 Politics of Science (3)
Journ 125 Environment, the Public and the Mass Media (3)
Journ 126 Writing About the Environment (3)
Journ 313 Special Topics in Science Writing (3)
Journ 17 Magazine Article Writing (3)
or or
Journ 114 Reporting of Public Affairs (3)
or or
Journ 113 Editing (3)
or or
Journ 312 Advanced Science Writing (3)

Recommended sequence of courses

freshman year, first semester (15 credit hours)

Math 21 Analytic Geometry and Calculus I (4)
Chem 21, 22 Introductory Chemical Principles and Lab (5)
Engl 1 Composition and Literature (3)
general elective (3)

freshman year, second semester (14 credits)

Math 22 Analytic Geometry and Calculus II (4)
Geol 1, 2 Principles of Geology and Lab (4)
Engl 2, 10, 14, or 16 Composition and Literature (3)
general elective (3)

sophomore year, first semester (16 credits)

Math 23 Analytical Geometry (4)
Phys 11, 12 Introductory Physics I and Lab (5)
Biol 1, 2 Principles of Biology and Lab (4)
Geol 211 Environmental Geology (3)

sophomore year, second semester (14 credits)

Phys 21, 22 Introductory Physics II and Lab (5)
Geol 12 Historical Geology and Stratigraphy (3)
general elective (3)
concentration course (3)

junior year, first semester (16 credit hours)

Chem 51, 53 Organic Chemistry and Lab (4)
Eco 311 Environmental Economics (3)
Geol 33 Introductory Mineralogy and Petrology
concentration course (3)
general elective (3)

junior year, second semester (15 credits)

Chem 23 Analytical Environmental Chemistry (3)
Biol 306 Ecology (3)
concentration course (3)
general electives (6)

Summer

Geol 341 Field Camp (6). Geology concentration only.

senior year, first semester (15 credit hours)

Biol 331 Evolution of Non-vascular Plants (3)
or or
Biol 303 Invertebrate Zoology (3)
or or
Biol 332 Vascular Plants (3)
or or
Biol 34 Comparative Anatomy (3)
Biol 35 Microbiology (3)
concentration course (3)
general electives (6)

senior year, second semester (15 credit hours)

CE 371 Environmental Health
or Engineering (3)
Biol 361 Sanitary Microbiology
concentration courses (6)
general electives (6)

FINE ARTS

Professor. Richard J. Redd, M.F.A., chairman.

Associate professor. Carlos J. Alvare, M. Arch., M.C.P.

Assistant professor. Gary M. Burnley, M.F.A.; Ricardo Viera, M.F.A.

Assistant professor (adjunct). Victor B. Caliandro, M.Arch.

Instructor. Laurence Fink.

The department of fine arts offers three major programs designed to develop the creative potential of the individual both on a personal and social level and to provide a foundation for graduate studies in fine arts.

The program for general art offers the student experience in drawing, painting, printmaking and sculpture which will nurture creative expression and growth as the artistic skills develop.

The program in pre-architecture focuses on urban concerns, both functional and aesthetic, which deal with problems of man, society and space. At least two years of additional study beyond the bachelor of science at Lehigh are necessary to complete an architectural program.

The art history program gives the student a foundation in the evolution of European art from ancient to modern times and is designed for those who wish to pursue this area of the humanities as a professional art historian. It is strongly advised that the student planning to major in art history have three years of a foreign language at the college level.

In addition to the above three major programs, individually structured programs may be planned such as general art with an architectural design emphasis, art history with a curatorial emphasis, architectural studies with a planning or historical preservation emphasis. The students, with guidance from faculty advisers, may assist in planning his or her own program. Double majors with psychology are possible for students seeking to go into art therapy careers.

The resources of a growing Lehigh University art collection, scheduled art exhibitions, field work and contact with area architects and planners, extend the art programs into campus and community. Several major museums within traveling distance facilitate the firsthand study of art. Students of art history do research in the art collection of the university.

Cooperation with nearby Moravian College and other colleges of the Lehigh Valley Association of Independent Colleges allows students to register for art courses in ceramics, crafts, sculpture, photography, etc., not offered at Lehigh.

Certain studio courses with limited space, i.e., FA 10, 11, 12, 13, 20, and 61 are restricted in enrollment and require consent of the department chairman.

General art major

Forty-two credit hours are required

required preliminary courses (15 credit hours)

FA 5	Introduction to the Visual Arts (3)
FA 10	Design or FA 20 Color (3)
FA 11	Basic Drawing (3)
FA 12	Three-Dimensional Design (3) or one other 3-D course
FA 23	Life Drawing (3)

required major courses (27 credit hours)

FA 220	20th-Century Art (3)
Art History	Any two courses (6)
Art Studio	Six courses, two at the advanced level (18)

Pre-architecture major

Fifty-eight credit hours are required.

required preliminary courses (22 credit hours)

Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Phys 11	Introductory Physics (4)
Phys 12	Introductory Physics Lab (1)
FA 3, 4	History of Architecture (6)
FA 13	Architectural Drawing (3)

required major courses (33 credit hours)

Mech I	Statics (3)
Mech II	Mechanics of Materials (3)
CE 159	Structural Analysis I (3)
CE 160	Structural Design (3)
FA 43	Architectural Design (3)
FA 143	Environmental Planning and Project (3)
FA 144	Intermediate Architectural Design (3)
FA 244	Advanced Architectural Design (6)
FA 200	20th-Century Architecture (3)
FA 151	History of Urban Design (3)
FA 341	Architectural Practice (3) or
FA 342	Architectural Theory (3)

Art History major

Thirty-six credit hours are required.

preliminary course

FA 1	Introduction to Art History (3)

required major courses

one of the following:

FA 10	Design (3)
FA 11	Basic Drawing
FA 23	Life Drawing (3)
Art 75	Ceramics I (Moravian) (4)

one of the following:

Gk 201	Archaeology of the Near East (3)
Gk 202	Archaeology of Greece (3)
Lat 203	Archaeology of Italy (3)

nine of the following, at least four at the 200 level, for 27 credit hours:

FA 3	History of Architecture I (3)
FA 4	History of Architecture II (3)
FA 102	Ancient Art (3)
FA 113	Medieval Art (3)
FA 115	Italian Renaissance Art (3)
FA 117	Baroque and Rococo Art (3)
FA 151	History of Urban Design (3)
FA 200	20th-Century Architecture (3)
FA 219	19th-Century Painting (3)
FA 220	20th Century Art (3)
FA 271	Readings (3)

Collateral courses are recommended, and in some instances may be substituted for the above in civil engineering, geology, government and social relations. For examples: SR 368; CE 13; Govt 357; Geol 211.

Undergraduate courses

1. Introduction to Art History (3) P
Development of painting and sculpture primarily in the Western tradition from paleolithic to modern times.

3. History of Architecture I (3) P fall
Man's expression through architecture from prehistoric through the Romanesque period. Conditioning influences, evolution of styles, the development of organic and inorganic types, in relation to structural purposes, and social expression.

4. History of Architecture II (3) P spring
Factors determining the development and spread of Gothic, Renaissance, and succeeding styles, the effects of discovery and exploration, the rise of romantic, classic, functional, international, and contemporary movements are examined as epochal expression. Principles of appreciation and aesthetic character in the scientific age.

5. Introduction to the Visual Arts (3) P fall
Principles of visual expression. Examples of art from various periods are examined in relation to their historical and cultural context, to their plastic organization and their significance as reflection of human experience.

10. Design (3) UP fall, alternate years
Design and composition in two dimensions. Basic color theory. Individual and group projects directed towards developing visual awareness. Prerequisite: consent of department chairman. Mr. Redd.

11. Basic Drawing (3) UP fall-spring
Concepts and practice of building and representing three-dimensional form. Methods and media of drawing. Prerequisite: consent of department chairman. Mr. Burnley.

12. Three-Dimensional Design (3) UP spring, alternate years
Individual and group projects directed toward developing design in three dimensions. Exploration of materials and their application. Prerequisite: consent of department chairman. Mr. Burnley.

13. Architectural Drawing (3) P fall
Plans, elevations, sections and details. Rendering and perspective in various media. Prerequisite: consent of department chairman. Mr. Burnley.

20. Color (3) UP alternate years
Projects directed toward building an awareness of color. Study and observation of the dynamics of color in theory and practice. Prerequisite: consent of department chairman. Mr. Redd.

23. Life Drawing (3) UP
Drawing from the live model as the fundamental experience towards building form. Prerequisite: consent of the department chairman. Mr. Burnley.

33. Painting (3) fall-spring
Painting in oil, acrylic or watercolor oriented toward developing individual creative expression combined with an understanding of the physical nature of the materials. Studio prerequisite: FA 10 or 11, or consent of the department chairman. Mr. Redd, Mr. Burnley.

37. Introduction to Printmaking (3) fall
A structured course in mono print, relief "block" printing and basic etching. Introducing materials and tools, stressing creative application and the conceptual aspects of the media. Prerequisite: FA 11. Mr. Viera.

38. Intaglio Printmaking (3) spring
Etching, engraving, drypoint, and aquatint. Investigation of plate surfaces, inks, grounds, acids and papers. Prerequisite: FA 11 or consent of the department chairman. Mr. Viera.

43. Architectural Design (3)
Basic architectural design. Function, selection and organization of spaces. Study of light, color and texture. Emphasis on creative concepts in consideration of total environment. Critiques and open juries. Prerequisite: FA 13 or CE 11, field experience or consent of department chairman. Mr. Alvare.

61. Introduction to Photography (3) P
Making and viewing of Photographs. Basic camera and darkroom techniques, mechanics and materials. Class discussion and assignments in photographic history to provide a context for and perspective on individual work. Individual and group projects. Instruction directed toward development and use of photography as an art medium. Prerequisite: consent of department chairman. Mr. Fink.

102. (Greek 102) Ancient Art (3) UP spring
A history of the visual arts in the ancient world from prehistoric to the period of Constantine the Great. Correlation with political, social, and literary background of each culture.

113. Medieval Art (3) UP
Architecture, painting, sculpture and the minor arts from the fall of Rome through the 14th century in Western Europe and the Byzantine Empire.

115. Italian Renaissance Art (3) UP every third year in fall
Painting and sculpture are examined as the outgrowth of conditions in Italy during the 14th, 15th, and 16th centuries: the influence of medieval thought and tradition, the awakening interest in nature, the effect of antiquity, especially the stimulus it gave to individual effort. Mr. Redd.

117. Baroque and Rococo Art (3) UP
The artistic environment of Europe from the Counter-Reformation to the French Revolution as illuminated by examples of painting, sculpture and architecture provides foundations for better comprehension of artistic principles. Historical, aesthetic and technical aspects of the art as basis for appreciation.

123. Advanced Life Drawing (3)
Advanced drawing from the live model. Prerequisite: FA 23. May be repeated for credit. Mr. Burnley.

133. Intermediate Painting (3) fall-spring
Problems in oil, watercolor, acrylic and mixed media. Prerequisite: FA 33. Mr. Redd, Mr. Burnley.

143. Environmental Planning and Project (3) fall-spring
Concentrated environmental design projects. Individual and team planning. Investigatory and cumulation procedures and problems. Content tailored to contemporary needs and student requirements—conferences, critiques. Closed juries. For majors only. May be repeated for credit. Mr. Alvare.

144. Intermediate Architectural Design (3) fall-spring
More advanced study in architecture and site design. Increase in scope and complexity of projects. Critiques and open juries. Prerequisite: FA 43 or consent of department chairman. Mr. Alvare, Mr. Caliandro.

145. Structure in Architecture (3) fall
Structural forms and systems; directed toward an understanding of various structural elements. Vocabulary of structural terms. Prerequisite: consent of department chairman or Mech 1. Mr. Caliandro.

151. History of Urban Design (3) fall
Historical development of urban design in the evolution of the city. Theories of city planning. Special emphasis is given to the social and economic parameters which determine physical design. Methods and practices used in the United States today. Seminar course. Prerequisite: FA 43 or consent of department chairman. Mr. Alvare.

152. Physical Planning and Design (3) spring
Solution of a physical planning problem with special emphasis on the relationship between the design functions and the social, economic and political programs under which the plan will develop. Studio course. Prerequisite: FA 151. Mr. Alvare.

200. 20th-Century Architecture (3) spring
History and theory of modern architecture from late 19th-century antecedents. Wright, LeCorbusier, and Mies van der Rohe, and major 20th-century schools of architectural design.

211. Advanced Drawing (3) fall-spring
Projects in creative drawing designed to build on concepts and practices initiated in basic drawing and life drawing. May be repeated for credit. Prerequisites: FA 11 and 23. Mr. Burnley.

219. 19th-Century Painting (3) fall, alternate years
From Neoclassicism through the sequential movements of Romanticism, Naturalism, Impressionism, and Post-Impressionism in the art of Europe and the U.S. Mr. Redd.

220. 20th-Century Art (3) spring
Sequential movements in contemporary painting and sculpture. Their interrelations as cultural expression. Museum reports and critical interpretation. Mr. Redd.

Fig. 812. — DIANA.
(After an ancient statue.)

233. Advanced Painting (3) fall-spring
Provides creative work in depth in a variety of painting media. Prerequisite: FA 133 or consent of department chairman. May be repeated for credit. Mr. Redd, Mr. Burnley.

237. Intermediate Printmaking (3) fall-spring
Aluminum plate lithography and basic serigraphy. Further exploration in relief and intaglio printing. Survey of special topics, reading in the history of printmaking, problems in edition printing and today's print market. Prerequisite: FA 37 or 38. Mr. Viera.

244. Advanced Architectural Design (1-3) fall-spring
Individual study, project or other assignment for advanced students or majors capable of progress beyond general course content or requirement. Content organized by the instructor and chairman of the department. Conferences and critiques. May be repeated for credit. Prerequisite: consent of department chairman. Mr. Alvare, Mr. Caliandro.

271. Readings (3) fall-spring
Readings in the visual arts for students who wish to pursue special interests in art history, art criticism or aesthetics not covered by the regular course offerings. Prerequisite: consent of department chairman.

273. Special Topics in Studio Practice (1-4) fall-spring
Individually directed projects for advanced students capable of undertaking independent creative work in applied art and photography. Prerequisite: consent of department chairman.

275. Research and Museology (1-3)
Research and reading on art objects in the Lehigh art collection. Curatorial problems in attribution, display, cataloguing and conservation. Each student completes a research report or equivalent. May be repeated for credit. Mr. Viera.

333. Media in Painting (3)
A painting course which focuses on historical techniques. Studio practice preparing and working in 15th and 16th century media. Reading on media and materials. Prerequisite: consent of department chairman. Mr. Redd.

337. Printmaking Workshop (3) fall-spring
Independent experimentation and work in a chosen graphic media for the advanced student. Photographic applications, conceptual problems and mixed media. Conferences and critiques. May be repeated for credit. Prerequisite: FA 237 or consent of department chairman. Mr. Viera.

341. Architectural Practice (3)
The architect and contemporary society. Office practice, management, planning, programming and systems. Contracts and specifications. Majors only or consent of the department chairman.

342. Architectural Theory (3) spring
Development of contemporary architectural thought. Philosophy of significant architectural writers and architects in relation to their projects and executed work, correlated with problems in current practice. Prerequisite: FA 3, 4, 200.

FIVE-YEAR PROGRAMS

Fig. 987. — THE GERFALCON.

Other program combinations leading to two degrees can be found under Arts-Engineering sequences or may be developed by consulting Graduate School requirements and the chairman of the appropriate department.

Electrical engineering and engineering physics

This curriculum is particularly well suited for students seeking thorough preparation in the field of physical electronics. The program adds to the basic electrical engineering curriculum a sequence of upper-level undergraduate physics courses.

The electrical engineering degree is conferred on the completion of the fourth year, and the engineering physics degree at the end of the fifth year.

freshman year (see page 40)

sophomore year, first semester (16 credits)

EE 11	Principles of Computing Techniques
Math 23	Analytical Geometry and Calculus III (4)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Lab II (1)
Eco 1	Economics (4)

sophomore year, second semester (17 credits)

EE 20	Introduction to Circuit Theory (4)
Math 205	Linear Methods (3)
Phys 31	Introduction to Quantum Mechanics (3)
	General Studies requirement (3)
	elective (3)

junior year, first semester (14-17 credit hours)

EE 104	Linear Systems & Signals (4)
EE 105	Electronic Circuits (4)
Math 231	Probability and Statistics or
Math 309	Theory of Probability (3)
	General Studies requirement (3)
	elective (0-3)*

junior year, second semester (17 credit hours)

EE 103	Physical Electronics (3)
EE 106	Electromechanics & Machines (3)
EE 236	Electromagnetic Fields I (3)
Phys 212	Electricity and Magnetism I (3)
EE 142	Junior Lab (2)
	mathematics elective (3)
	elective (3)

summer

EE 100	Industrial Employment

senior year, first semester (15-18 credit hours)

EE 111	Proseminar (1)
EE 151	Senior Lab I (2)
EE 237	Electromagnetic Fields II (3) or
Phys 213	Electricity and Magnetism II (3)
Phys 215	Particles and Fields I (3)
EE	departmental electives (6)
	elective (0-3)*

*Please refer to description of normal programs, page 40.

senior year, second semester (18 credit hours)

Phys 216	Particles and Fields II (3)
EE	Departmental Electives (9)
	General Studies requirement (3)
	elective (3)

fifth year, first semester (17 credit hours)

Phys 192	Advanced Lab (2)
Phys 340	Thermal Physics (3)
Phys 362	Atomic and Molecular Structure (3)
Math 322	Methods of Applied Analysis I (3)
	approved elective (3)
	elective (3)

fifth year, second semester (15 credit hours)

Phys 254	Optics Lab (2)
Phys 171	Proseminar (1)
	approved elective(6)
	electives (6)

Note: Approved electives are two courses selected from Phys 363, 364, 365, 366, 367, 368, 369.

Engineering-M.B.A. program

This program is designed to meet the needs of competent students in any of the engineering curricula who wish to add to their engineering studies training in business management at an advanced level.

The time involved is five years, but a summer session would be necessary to attain both a bachelors degree in engineering and a masters degree in business adminstration or management science. In addition to a course in economics, which is required of all engineering undergraduates, thirty hours of basic business courses are necessary to meet the background requirement for the M.B.A. degree. If as much as eighteen hours of such courses can be rostered in the student's engineering curriculum, the remaining twelve hours can be obtained in one summer. Otherwise, attendance at an additional summer session is necessary. Candidates for each program will be required to take the Graduate Management Admission Test.

For background courses required for the M.B.A., engineering students should see the section on graduate study in business and economics, and consult with Max D. Snider, associate dean of the College of Business and Economics.

Arts-M.B.A. program

This program is designed to meet the needs of students in the College of Arts and Science who wish to add to their arts studies training in business management at an advanced level.

The time involved in the program is five years, but a certain amount of summer session work may be necessary for majors in the sciences to attain both a bachelor of arts and a masters degree in business administration within that period. In addition to one course in economics, which can be counted as part of the social science distribution requirements, thirty hours of basic business courses are needed to meet the background requirements. Thirty hours of requirements for the master of business administration degree must also be completed.

For background courses for the M.B.A., students should see the section on graduate study in business and economics, and consult

with Max D. Snider, associate dean of the College of Business and Economics. Many of the background courses can be rostered in the student's arts curriculum.

B.S. in engineering, master in materials

Sophisticated designs of modern systems depend to a major extent upon an appreciation of the world of materials. Judicious selection of materials in design, as well as the design of materials *per se*, requires a depth of understanding which can seldom be achieved in typical undergraduate programs.

Especially for the chemical, civil, electrical and mechanical engineer, the bachelor of science in engineering-masters in materials program provides a means of developing this depth of understanding.

Undergraduates in the various branches of engineering interested in such a program can qualify for the master of science in materials program by careful selection of their technical electives. Students can thus augment the scope of the four-year bachelor of science program in a traditional engineering branch with an understanding of materials behavior gained in a graduate program.

Whereas this combined five-year program is intended for those entering industry, it provides sufficient flexibility to enable those interested in materials research and/or development to continue toward the Ph.D. degree.

Undergraduates interested in the opportunities offered by the program should consult their departmental advisers and also the chairman of the department of metallurgy and materials science. To ensure satisfactory completion of prerequisites, such consultation should precede the beginning of the junior year. Examples of typical prerequisite patterns and programs are available in the department of metallurgy and materials science.

FOREIGN CAREERS

Finn B. Jensen, chairman of economics and director of the foreign careers program.

Major in the College of Arts and Science

The interdepartmental major in foreign careers is designed to give students the grounding in language, history, economics, and related subjects needed for successful work with private industry or governmental agencies in their overseas activities.

Each student in the program schedules all courses in the common core and in one of the options. In addition, he or she will, in consultation with the director, select courses in language, history, and other subjects which will provide an intensive knowledge of the culture of the area in which the student is interested. Students electing the Russian area option will be expected to study Russian.

The program also affords a broad base for graduate study in social sciences and business administration. Students interested in this aspect of the major sequence should consult the director early in their college careers.

Common core

required preliminary courses

Eco 1	Economics (4)
Govt 3	Comparative Politics (3)
Math 21	Analytic Geometry and Calculus I (4) or
Math 41	BMSS Calculus I (3)
Eco 45	Statistical Method (3)

concentration in the Latin American area

Eco 305	Economic Development of Latin America (3)
SR 367	Change and Conflict in Latin America (3)
Hist	Six hours of Latin American History (6)

concentration in the European area

Eco 309	Comparative Economic Systems (3)
Eco 343	European Economic Integration (3) or
IR 101	Politics of European Integration (3)
Hist	Six hours of European history (6)

concentration in the Russian area

Eco 309	Comparative Economic Systems (3)
Govt 61	The Soviet Political System ( )
IR 133, 134	Diplomacy of Russia (6)
IR 334	The Soviet Union in World Affairs (3)

foreign trade option

Acctg 51	Essentials of Accounting (3) or
Acctg 108	Fundamentals of Accounting (3)
Eco 229	Money and Banking (3)
Eco 339, 340	International Trade and Finance (6)
Eco	In consultation with the adviser (6)

Public administration option

Acctg 51	Essentials of Accounting (3) or
Acctg 108	Fundamentals of Accounting (3)
IR 353	International Institutions
IR 361	International Law (3)
Eco 353	Public Finance (3)
Govt 360	Public Administration (3)
Govt 363	Contemporary Political Philosophy (3)
Govt 364	Issues in Contemporary Political Philosophy
Govt 322	Politics of Developing Nations (3)

Open Option

In place of any of the three preceding options, a student may take an open option by meeting the advanced course requirements for one of the other College of Arts and Science majors. The open option is most feasible with humanities and social science majors but will require a careful combining of distribution courses and free electives with the eighteen hours normally given to the option. Students interested in the open option should consult the director of the foreign careers major as early as possible.

FUNDAMENTAL SCIENCES

Curtis W. Clump, associate dean of the College of Engineering and Physical Sciences, and director of fundamental sciences program.

The curriculum in fundamental sciences is designed to enable students to achieve a breadth of academic background in the fields of modern science and at the same time, through an option, to master the discipline of one of them, about to the level of a minimum bachelor's program. The options and electives provide sufficient flexibility to enable a student to prepare for employment in industry or government, or approach adequacy for graduate study in a field.

The program offers an excellent opportunity for students who are uncertain of their desire for a career in a particular field to proceed on a broad program which can lead to a bachelor's degree. If the student's interest crystallizes in an established field, transfer to that major will normally be possible with only a minimum of dislocation, especially if the student has completed the introductory courses in that field.

Fundamental science students are required to concentrate in a major. Students can organize acceptable programs including the substantive course elements related to any one among several areas such as chemistry, physics and mathematics, biology, earth and space science, science of living systems, materials, computer science, and architecture, or meaningful combinations of any two of these.

The freshman year is identical with that of all students in the college of Engineering and Physical Sciences. The General Studies requirements of the college must also be satisfied. The discipline of a field will be provided by the inclusion of at least fifteen semester hours or from a combination which consititutes the core of one of the combination fields. Examples of these combination majors include: biochemistry, geophysics, bioengineering, applied mathematics, ocean engineering, and computer science. Students pursuing double concentrations may, with the approval of their adviser, substitute for one of the science courses of the sophomore year, a basic course in the area of concentration.

The details of the student's program are worked out by the student with the advice of the curriculum adviser, and with the approval of the department chairmen concerned with the fields of concentration.

freshman year (see page 40)

sophomore year, first semester (15-16 credits)

Biol 21, 22	Principles of Biology and Lab (4) or
Geol 1	Principles of Geology (3)
Chem 51, 53	Organic Chemistry and Lab (4)
Math 23	Analytical Geometry and Calculus III (4)
Eco 1	Economics (4)

sophomore year, second semester (17 credits)

major (3)
approved elective (3)
Math 205 Linear Methods (3)
Phys 21, 22 Introductory Physics II & Lab (5)
General Studies elective (3)

junior year, first semester (15-16 credit hours)

Geol 1 Principles of Geology (3) or
Biol 21, 22 Principles of Biology and Lab (4)
Psych 1 Introduction to Psychology (3)
Math 231 Probability and Statistics (3)
major (3)
General Studies elective (3)

junior year, second semester (15 credit hours)

approved electives (6)
major (6)
elective (3)

senior year, first semester (15-18 credit hours)

approved electives (6)
major (6)
General Studies elective (3)
elective (0-3)*

senior year, second semester (15-18 credits)

Phil 42 The Scientific Process (3)
aproved elective (3)
major (6)
General Studies elective (3)
elective (0-3)*

*Please refer to description of normal programs, page 40.

GEOLOGICAL SCIENCES

Professors. Charles B. Sclar, Ph.D., chairman; James M. Parks, Ph.D., director, Center for Marine and Environmental Studies; Adrian F. Richards, Ph.D.; J. Donald Ryan, Ph.D.; Dale R. Simpson, Ph.D.

Associate professors. Bobb Carson, Ph.D.; Paul B. Myers, Jr., Ph.D.

Assistant professors. Edward B. Evenson, Ph.D.; John R. Sumner, Ph.D.

Geology, and related sciences such as geophysics and geochemistry, deal with natural phenomena on or within the earth. Each is a science which makes use of other more fundamental sciences in its practice; hence, the student preparing for a career in one of the geological sciences combines study in geology with a broad understanding of physical, chemical, and biological principles.

Lehigh offers two undergraduate programs in geological science, one leading to the degree of bachelor of science in geological sciences, the other to the degree of bachelor of arts. The bachelor of science curriculum is looked upon as the professional route. The B.A. program requires fewer credits for graduation (121 vs. 127 credit hours), fewer courses in collateral sciences and mathematics (34 vs. 37 credit hours), and fewer geology courses (32 vs. 42 credit hours). Candidates for the B.S. degree also are required to take fifteen credit hours in approved professional electives. The professional electives permit the student to arrange for an informal option in an area such as geophysics, geochemistry, engineering geology, etc.

Students electing the bachelor of arts program are required to meet the distribution requirements of the College of Arts and Science; candidates for the bachelor of science degree take thirty credit hours of nonprofessional electives in place of the distribution requirements. There is no foreign language requirement in either program. However, it is strongly recommended that all students planning on attending graduate school, who have not previously studied either French, German or Russian, should include courses in one of these languages in their undergraduate programs.

Attendance at an approved summer geology field camp is required in both programs.

Both the bachelor of science program and the bachelor of arts program provide preparation for graduate school. Qualified students may be given permission at the end of the junior year to enter a program wherein they are able to begin work toward a graduate degree during the senior year. Students enrolled in this program may be able to complete all requirements for the master of science degree with as little as one year of study beyond the baccalaureate.

Geological training may be utilized in industry (especially in the petroleum, mining, highway construction, ceramics, and metallurgical industries), government service, natural resource management, and in secondary school and college teaching. Students planning on careers in industry are advised to register for the bachelor of science program.

A major in geophysics is offered with faculty from cooperating departments. This program is described on page 126.

B.S. in geological sciences

One-hundred and twenty-seven credit hours are required.

college and university requirements (36 credit hours)

Engl 1 Composition and Literature (3)
Eng 2, 10,
14, or 16 Composition and Literature (3)
electives (30 credit hours)

Elective courses are nonprofessional courses designed to give the student a broad understanding in traditional and contemporary fields of thought outside of natural science and mathematics. The courses are chosen by the student. The elective program includes a large number of courses broadly distributed among the various areas of the humanities and the social sciences.

the major program (90 credit hours)

mathematics (12 credit hours)

Math 21 Analytic Geometry and Calculus I (4)
Math 22 Analytic Geometry and Calculus II (4)
Math 23 Analytic Geometry and Calculus III (4)

collateral sciences (22 credit hours)

Chem 21, 22 Introductory Chemical Principles and Lab (5)
Chem 31 Chemical Equilibria in Aqueous Systems (3)
Phys 11, 12 Introductory Physics I and Lab (5)
Phys 21, 22 Introductory Physics II and Lab (5)
Biol 21, 22 Principles of Biology and Lab (4)

geology (42 credit hours)

Geol 1 Principles of Geology (3)
Geol 2 Introductory Geology Laboratory (1)
Geol 10 Computer Applications (1)
Geol 12 Historical Geology (3)
Geol 23 Structural Geology (3)
Geol 33 Introductory Mineralogy and Petrology (3)
Met 210 Metallurgical Thermodynamics (3)
Geol 301 Introduction to Geophysics (3)
Geol 311 Paleontology (3)
Geol 313 Sedimentology (3)
Geol 333 Crystallography (3)
Geol 334 Petrology and Petrography (4)
Geol 336 Mineral Phase Relations (3)
Geol 341 Field Camp (6)

approved professional electives (15 credit hours)

Courses approved to fulfill this requirement should form a coherent package supporting the professional objectives of the student.

B.A. with geology major

One-hundred and twenty-one credit hours are required.

college and university requirements

Engl 1 Composition and Literature (3)
Engl 2, 10,
14 or 16 Composition and Literature (3)
distribution requirements (see page xx)

the major program (65 credit hours)

mathematics (12 credit hours)

Math 21 Analytic Geometry and Calculus I (4)
Math 22 Analytic Geometry and Calculus II (4)
Math 23 Analytic Geometry and Calculus III (4)

collateral sciences (22 credit hours)

Chem 21, 22 Introductory Chemical Principles and Lab (5)
Chem approved elective (3)
Phys 11, 12 Introductory Physics I and Lab (5)
Phys 21, 22 Introductory Physics II and Lab (5)
Biol 21, 22 Principles of Biology and Lab (4)

geology (32 credit hours)

Geol 1 Principles of Geology (3)
Geol 2 Introductory Geology Laboratory (1)
Geol 10 Computer Applications (1)
Geol 12 Historical Geology (3)
Geol 23 Structural Geology (3)
Geol 33 Introductory Mineralogy and Petrology (3)
Geol approved electives (12)
Geol 341 field camp (6)

Fig. 1357.—CAVERN OF SUTZKELLIR.

Combined B.A. or B.S. and M.S. program in geological sciences

The department of geological sciences offers a combined bachelor of arts or bachelor of science and master of science program. Students working toward the bachelor of arts in geology or the bachelor of science in geological sciences who are enrolled in this program are permitted to take courses which apply toward the master of science degree during their senior year. Usually this will permit completion of the master of science program within one year of receiving the bachelor's degree.

During the student's senior year, the normal undergraduate tuition will cover the costs of all courses taken including those which are taken for graduate credit. After receiving the bachelor's degree, students registered in the program who have done satisfactory work may acquire upon admission to the graduate school full-time graduate status, and as such, they will become eligible to apply for appointment to a teaching assistantship, research assistantship, or graduate fellowship.

The program is designed for those students who upon completing the junior year and the field camp requirement need less than thirty credit hours to complete work for the bachelor's degree. Students accepted into the program generally also must rank in the upper half of their class and must have at least a B average in all geology courses completed.

Application for admission to the program should be made during the spring semester of the junior year (generally at the time of preregistration or later) and must be approved by the department faculty and the dean of the Graduate School. The application must include: 1. a tentative master of science program approved by the department chairman, and 2. a roster, also approved by the department chairman showing which courses taken during the senior year apply toward the bachelor's degree and which courses apply toward the master's degree. No more than fifteen credit hours per semester may be rostered. A total of 151 credit hours is required for the combined B.A.-M.S. program and a total of 157 credit hours is required for the combined B.S.-M.S. program. All of the normal requirements for each degree as outlined must be fulfilled.

Students enrolled in the program should make application for admission to full-time graduate status after completing the first semester of the senior year.

Undergraduate courses

1. Principles of Geology (3) fall-spring
Fundamental concepts of geology; the composition, structure, and development of the earth; processes of geological change. Lectures and field trip.

2. Introductory Geology Laboratory (1) fall-spring
Recommended laboratory given concurrently with Geol 1. Study of rocks and minerals, rock structures, land forms. Prerequisite: Geol 1 previously or concurrently.

10. Computer Applications (1) fall
The use of computers in the solution of geological problems. Introduction to Fortran; the use of published and available programs. Mr. Parks.

12. Historical Geology and Stratigraphy (3)
Origin and evolution of the earth and its parts: continents, ocean basins, hydrosphere, and atmosphere; origin and evolution of life. Stratigraphic correlation, facies change, breaks in the record, paleogeographic and paleoenvironmental reconstruction. Prerequisite: Geol 1 or 101. Mr. Ryan.

23. Structural Geology (3) spring
The application of basic concepts of stress and strain and experimental data to study of the developments of faults, folds, and other deformational structures in the earth's crust. Introduction to the larger-scale problems of geotectonics. Prerequisite: Geol 1 or 101. Mr. Myers.

33. Introductory Mineralogy and Petrology (3) fall
Principles of crystallography, mineralogy, and petrology; megascopic study, identification, and description of common minerals and rocks. Lectures and laboratory. Prerequisites: Geol 1 or 101, Chem 21. Mr. Sclar.

63. Introduction to Oceanography (3) spring
A survey of the physical, chemical, biological, and geological nature of the oceans. Prerequisite: one year of science (biology, chemistry, geology or physics). Mr. Carson.

81. Aerial Photo Interpretation (1) spring
Use of aerial photographs and space imagery to obtain qualitative and quantitative terrain information. Applications in geology, ecology, engineering, land planning. Mr. Ryan.

97. Man-Ocean Interaction (3) fall
An introduction to the science of oceanography with an assessment of selected global problems, including energy extraction, climate modification, nodule mining, and pollution. Mr. Richards

101. Geology for Engineers (3) fall
A study of the materials which make up the earth, the physical, chemical, and environmental history that they relate, and the processes that act to change them. Designed primarily for upperclass science and engineering majors. Lectures and laboratory-recitation. Mr. Myers.

191. (Biol 191) Environmental Science Seminar (1)
Seminar on current problems and developments in environmental science. May be repeated for credit. Prerequisite: sophomore standing. Messrs. Evenson and Bell.

For advanced undergraduates and graduates

201. Earth Sciences 1—Geology (3) summer
Fundamental concepts of geology; composition and structure of the earth, dynamics of natural processes, evolution and development of the earth. Must be taken concurrently with Geol 203. Designed for secondary school science teachers. Prerequisite: graduate standing or consent of department chairman.

203. Geology Workshop (3) summer
Field and laboratory exercises in geology. Must be taken concurrently with Geol 201.

211. Environmental Geology (3) fall
Analysis of the dynamic interaction of geologic processes and human activities. Catastrophic geologic processes, resource limitations and development, pollution of geologic systems, environmental legislation, engineering case studies. Mr. Evenson.

281. Geological Research (1-6) fall
Independent investigation of a special problem in the field, laboratory, or library. Prerequisite: consent of department chairman.

282. Geological Research (1-6) spring
Similar to Geol 281. May be elected as a continuation or separately. Prerequisite: consent of department chairman.

301. Introduction to Geophysics (3) fall
Application of physical principles to solution of crustal and near-surface geologic problems: reflection and refraction seismology, gravity, magnetic and electrical methods. Prerequisites: Math 21, Phys 21, and Geol 1 or 101. Mr. Sumner.

302. Physics of the Earth (3) spring
Application of physical principles to the earth: origin, geochronology, heat generation and flux, seismology, gravity, magnetism and tectonics. Prerequsites: Math 21, Phys 21. Mr. Sumner.

306. Geophysical Field Techniques (3) spring
Geophysical field investigation in an area of geological interest. Theory and application of seismic, gravity, magnetic, and electrical methods; data collection, interpretation, and a written report. Individual assignments of a geophysical field in an area of geological interest. Prerequisite: Geol 301 or consent of department chairman. Mr. Sumner.

311. Paleontology (3) spring
Morphology of invertebrate fossils, their use in interpreting geologic history; evolution of the faunas and floras. Lectures and laboratory work. Prerequisite: Biol 21. Mr. Parks.

312. Geomorphology (3) spring
Systematic study of the origin, evolution, and distribution of the earth's topographic features. Land forms analyzed in terms of chemical and physical processes responsible for their development. Lectures and field trips. Prerequisite: Geol 1 or 101. Mr. Evenson.

313. Sedimentology (3)
The processes that control weathering, transportation, and deposition of sediments; the characteristics of sediments and environments of deposition. Lectures and laboratory. Prerequisite: Geol 333. Mr. Carson.

314. Glacial and Quaternary Geology (3) spring
Study of the origin, distribution, and movement of present and past glaciers. Special emphasis on glacial land forms and deposits, quaternary stratigraphy and dating techniques, periglacial phenomena, and Pleistocene environments. Lectures and required field trips. Prerequisite: Geol 1 or 101. Mr. Evenson.

315. Coastal Sedimentation (1)
Origin, dispersal, and deposition of clastic sediments in the shore zone with emphasis on the barrier beach-salt marsh complex. Lectures and laboratory conducted at The Wetlands Institute. Not offered on a regular basis. Prerequisite: consent of department chairman.

317. (Biol 317) Evolution (3)
The origin of species and higher categories with emphasis on animals. Isolating mechanisms, population structure, rates of evolution, extinction. Prerequisite: two semesters of biology or consent of department chairman. Mr. Barber.

319. Regional Stratigraphy (3) spring
Studies of sedimentary rock sequences in North America illustrating principles of correlation, facies change, methods of environmental and paleogeographic reconstruction. Mr. Ryan.

320. Advanced Computer Applications (1-3)
Independent investigation of special problems utilizing computer techniques. Prerequisite: Geol 10 or consent of department chairman. Mr. Parks.

321. Statistical Applications (3) fall
Statistical models applicable to geological and geophysical field and laboratory studies. Analysis of variance, applications of the chi-square distribution, analysis of covariance, linear, nonlinear and multiple regression, and distribution-free methods. Mr. Carson

333. Crystallography (3) fall
Fundamentals of crystallography and crystal structure; patterns and symmetries, symmetry notations, crystal morphologies and internal structure, principles of crystal chemistry. The anisotropy of crystalline materials with special reference to crystal optics. Lectures and laboratory. Prerequisite: Geol 33, previously or concurrently. Mr. Simpson.

334. Petrology and Petrography (4) fall
Evolution of crystalline rocks and their distribution in space and time; physical and chemical factors in igneous and metamorphic processes. Microscopic study of rocks. Lectures, laboratory work, and field trips. Prerequisite: Geol 333. Mr. Myers.

336. Mineral Phase Relations (3) spring
Principles of phase equilibria; unicomponent and multicomponent condensed systems and multicomponent systems with volatile phases. The application of phase relation studies to mineralogical and geological problems. Prerequisite: Geol 333. Lectures and laboratory. Mr. Simpson.

337. (Met 333) X-ray Methods (3) fall
Fundamentals and experimental methods of X-ray techniques. Application to various materials problems including diffraction, radiography, fluorescent analysis. Lectures and laboratory work. Prerequisite: Phys 21, Met 91 or equivalent. Mr. Kraft.

338. (Met 334) Electron Metallography (4) spring
Fundamentals and experimental method of one or more of the electron beam techniques. Specific topics include electron optics, electron beam interactions with solids, electron diffraction, chemical microanalysis, scanning electron microscopy, conventional transmission and scanning electron microscopy. Applications to the study of the structure of materials are given. Special laboratories are given in cooperation with other departments as required. May be repeated for credit if new material is presented. Prerequisite: consent of department chairman. Messrs. Williams and Goldstein.

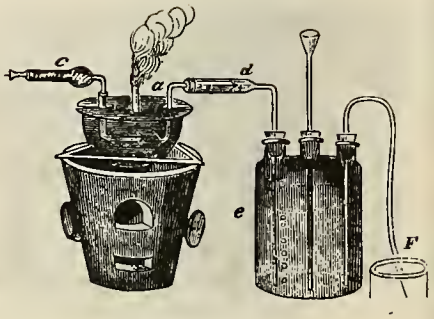

Fig. 310. — STEAM BATH.

341. Field Geology (6) summer
Field study and geologic mapping of sedimentary, igneous-metamorphic, and glacial deposits in the Rocky Mountains of northwestern Wyoming, and southeastern Idaho. Additional short studies in the Badlands and Black Hills of South Dakota, the Grand Tetons, Yellowstone Park, Craters of the Moon Park, and other areas in the Rocky Mountain region. Six weeks in the field. Summer session. Prerequisite: consent of the department chairman. Messrs. Evenson and Myers.

342. Advanced Glacial Geology (3)
Seminar on advanced topics in glacial geology; review of classic and contemporary literature. Topics include dynamics of glacier movement, glacial landforms and deposits, glacial stratigraphy. Occasional field trips. Prerequisite: Geol 314 or consent of department chairman. Mr. Evenson.

344. Advanced Geomorphology (3)
Seminar on advance topics in geomorphology. Occasional field trips. Prerequisite: Geol 312 or consent of department chairman. Mr. Evenson.

351. Petroleum Geology (3)
Origin, migration, and accumulation of petroleum and natural gas; general principles of exploration and production. Prerequisites: Geol 23 and Geol 313 previously or concurrently. Mr. Parks.

352. Applied Mineralogy (3)
Methods and approaches to the solution of industrial and environmental problems employing modern mineralogical techniques, especially transmitted- and incident-light polarizing microscopy and X-ray powder diffraction. Case histories of interest to geologists, chemists, ceramists, chemical, metallurgical, and mineral engineers, environmental engineers, and materials scientists. Lectures and laboratory. Prerequisite: Geol 333. Mr. Sclar.

356. Ground Water (3)
The geology and geochemistry of ground water. Techniques used in prospecting for ground water, ground water law, management and conservation, evaluation and planning. Prerequisites: Chem 21, 22, Geol 23. Mr. Myers.

357. Economic Geology (3) spring
The formation of mineral deposits and the occurrence and characteristics of deposits of economic importance. Includes metals, nonmetals and fuels. Lectures, laboratory work and inspection trips. Prerequisite: Geol 1. Mr. Simpson.

372. Principles of Geochemistry (3) spring
Synthesis of the geological, chemical, physical, and astronomical observations regarding the geochemical evolution of the earth, its internal constitution, and the physico-chemical processes which modify the crust. Crystal-chemical controls on the abundance and distribution of the chemical elements. Experimental high-pressure studies of geochemical significance. Shock metamorphism as a geochemical process on the surface of the earth, moon and planets. Mr. Sclar.

381. Meteorology (3) fall
Principles of meteorology; composition of the atmosphere, physics of the air, weather systems, weather instruments and forecasting. Two lectures, one laboratory. Mr. Jenkins.

For graduates

The graduate program in geology is mainly directed toward the study of geologic processes. Candidates for the master's degree receive instruction in most fields of geology and are expected to take courses in appropriate collateral fields of science. Advanced graduate students, working toward the doctorate, specialize in one field of geology.

Research is an important part of the graduate program. In general, students are encouraged to choose research problems which for their solution require the use of integrated laboratory and field studies.

Candidates for the master of science degree are required to complete a thesis (six credit hours) which must be presented in the form specified by the Graduate School. The research and writing of the thesis will be done under the direction of the thesis director who must be a member of the faculty of the department. The thesis director and two other members will constitute the thesis committee for the master of science candidate.

Students who wish to qualify for admission to candidacy for the doctor of philosophy degree must take the departmental qualifying examination during the semester in which they expect to complete the requirements for the master of science degree. Those who enter the program with a master of science degree should take the qualifying examination no later than the second semester of residence.

Candidates for the Ph.D. degree must demonstrate through examination a thorough reading knowledge of one foreign language, generally French, German, or Russian.

Other requirements for graduate degrees are listed in the Graduate School section.

Special departmental research facilities of interest include: Norelco X-ray source, diffractometer, and powder cameras, complete petrographic and incident-light microscopy facilities, hydrothermal apparatus for experimental mineralogy, belt-type ultra-high-pressure apparatus for upper mantle studies, soft-sediment deformation apparatus, carbon-hydrogen analyzer, Sharples supercentrifuge, Worden gravimeter, Geometrics portable proton magnetometer, Saltzman map projector, standard equipment for field mapping, and a completely equipped marine geotechnical laboratory.

The following major analytical facilities are available on campus to students and staff of the department: fully automated ARL electron microprobe, Philips 300 electron microscope completely equipped for transmission and diffraction, ETEC scanning electron microscope with nondispersive analysis capability, and Perkin Elmer automated double-beam infrared spectrophotometer.

402. Electrical Methods (3)
Electrical properties of rocks and minerals; the principles of potential distribution in DC and AC fields. Prerequisites: mathematics through calculus. Mr. Sumner.

404. Seismic Exploration (3)
Theory, field methods, and interpretation techniques in refraction and reflection seismology. Prerequisite: Geol 301. Mr. Sumner.

405. The Earth's Magnetism (3)
Terrestrial magnetism, rock magnetism, history of the geomagnetic field, spherical harmonics, and the interpretation of magnetic anomalies. Prerequisite: Phys 21. Mr. Sumner.

411. Advanced Paleontology (3)
Classification, evolution, biometrics and paleoecology; study of fossil and modern populations and assemblages. Lectures and laboratories. Prerequisite: Geol 311. Mr. Parks.

413. Advanced Topics in Sedimentology (1-3)
Study of the origin, dispersal, deposition, and diagenesis of sediments and sedimentary rocks. May be repeated for credit. Prerequisite: Geol 313. Mr. Carson.

417. Sedimentary Petrography (3)
The theory and application of petrographic methods in the study and classification of sedimentary rocks. Prerequisite: Geol 334. Mr. Ryan.

418. Sedimentary Petrogenesis (3)
The origin and development of sedimentary rock types; mineral provenance, environment of deposition, diagenesis, sediments in time, stratigraphic synthesis. Prerequisite: Geol 417. Mr. Ryan.

419. Sedimentary Basin Analysis (1)
Seminar on the use of directional features, petrographic variations, and other primary physical properties of sedimentary rock which make possible reconstruction of ancient sedimentary basins and sedimentary dispersal systems within such basins. May be repeated for credit. Mr. Ryan.

421. Global Tectonics (3) fall
Topics include upper mantle composition and configuration, interrelations between the earth's crust and upper mantle, geophysical data related to hypotheses in global tectonics, continental drift and the plate model. Seminars and lectures. Mr. Myers.

422. Regional Tectonics (3) spring
Concepts of global tectonics as applied to the geology of specific areas of the earth's crust. The tectonics of the Alpine-Himalayan chain, Rockies, Caledonides, Appalachian, coast ranges, and African Rift system are among subjects considered. Seminars and lectures. Prerequisite: consent of department chairman. Mr. Myers.

424. Advanced Structural Geology (3) alternate years
The theory and application of analytical methods in the study of rock deformation; experimental deformation, petrofabric analysis; statistical field methods. Mr. Myers.

425. Seminar on Tectonics (1)
Seminar on contemporary topics in tectonics. May be repeated for credit. Mr. Myers.

435. Advanced Mineralogy (3)
Topics of contemporary interest in mineralogy. Mr. Simpson.

436. Advanced Mineralogy (3)
Similar to Geol 435. May be elected separately. Offered as required. Mr. Simpson.

437. Advanced Igneous Petrology (3) alternate years
Origin of the diversity of igneous rocks as

revealed by field and laboratory studies. Lectures, laboratory and field trips. Mr. Sclar.

438. Advanced Metamorphic Petrology (3) alternate years
Processes involved in the transformation of rock masses under high pressure and temperature. Problems of the deep crust and upper mantle. Lectures, laboratory and field trips. Mr. Sclar.

439. Seminar on Petrology (1)
Critical review and assessment of current literature on major topics in petrology. May be repeated for credit. Mr. Sclar.

444. (Biol 444) Multivariate Analysis (3)
The strategy of the application of multivariate analysis techniques to problems in geology and biology. Analysis of large data matrices by factor analysis, cluster analysis, discriminant function analysis, ordination and related techniques. Examples from both geology and biology. Perequisites: Geol 10 and 321 or approved equivalents. Messrs. Parks and Carson.

454. Genesis of Metalliferous Deposits (3) alternate years
Petrological concepts regarding the origin of metalliferous ore deposits. Laboratory includes ore-mineral synthesis, ore microscopy, and electron microprobe analysis of ores. Field examination of ore deposits at operating mines. Mr. Sclar.

456. Advanced Topics in Economic Geology (3)
Modern concepts bearing on the nature and origin of ore deposits. Lectures, seminars, field trips. Prerequisite: consent of department chairman. Mr. Simpson.

461. Marine Geology (3) alternate years
Geology of the margins and the floors of the oceans. Mr. Carson.

462. Paleoecology (3) alternate years
Reconstruction of paleoenvironments based on principles of paleoecology and sedimentary petrology. Prerequisites: Geol 311, 313. Mr. Parks.

471. High-Pressure Petrology (3)
High-pressure phase transformations, phase equilibria, and melting phenomena in multicomponent systems of petrological importance as applied to problems of the deep crust and upper mantle in the pressure range 15 to 150 kilobars at temperatures to 1500 degrees C. Effect of water as a free phase at high pressure. Lectures and laboratories. Mr. Sclar.

472. Solution Geochemistry (3)
The processes of solution, transport, and deposition under hydrothermal conditions. Mr. Simpson.

480. (Biol 480) Marine Science Seminar (1)
An advanced interdisciplinary seminar on various problems of marine sciences, with visiting speakers and student presentations.

481. Geological Investigation (1-6) fall-spring
Research on a special problem; field, laboratory, or library study; report required. Credit above three hours granted only when a different problem is undertaken.

482. Geological Investigation (1-6) fall-spring
Similar to Geol 481. Credit above three hours granted only when a different problem is undertaken.

490. Special Topics (1-6)
An extensive study of selected topics not covered in more general courses.

491. Special Topics (1-6)
Similar to Geol 490. May be elected separately.

GEOPHYSICS

John R. Sumner, director and assistant professor of geophysics.

Geophysics is the branch of earth sciences which deals with the exploration of the earth and its history by physical means. Geophysicists provide society with necessary energy and mineral resources. The program is designed to provide the background needed for graduate work in geophysics or the preparation for employment in the petroleum and mineral industries.

Bachelor of Science degree

One-hundred-twenty-six credit hours are required.

college and university requirements (36 credits)

Engl 1	Composition and Literature (3)
Engl 2, 10, 14, 16	(3)
	electives (30 credit hours)

Elective courses are nonprofessional courses designed to give the student a broad understanding in traditional and contemporary fields of thought outside of natural science and mathematics. The courses are chosen by the student. The elective program includes a large number of courses broadly distributed among the various areas of the humanities and the social sciences.

The major program (90-95 credit hours)

Mathematics (18 credit hours)

Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)
Math 205	Linear Methods (3)
Math 322	Methods of Applied Analysis I (3)

collateral sciences (eight credit hours)

Chem 21, 22	Introductory Chemical Principles and Lab (5)
Met 210	Metallurgical Thermodynamics (3)

Physics (25 credit hours)

Phys 11	Introductory Physics I (4)
Phys 12	Introductory Physics Laboratory I (1)
Phys 21	Introductory Physics II (4)
Phys 22	Introductory Physics Laboratory II (1)
Phys 31	Introduction to Quantum Mechanics (3)
Phys 191	Laboratory Techniques (2)
Phys 212	Electricity and Magnetism I (3)
Phys 213	Electricity and Magnetism II (3)
Phys 215	Particles and Fields I (3)

Geology (29 credit hours)

Geol 1	Principles of Geology (3)
Geol 2	Introductory Geology Laboratory (1)
Geol 10	Computer Applications (1)
Geol 12	Historical Geology (3)
Geol 23	Structural Geology (3)
Geol 33	Introductory Mineralogy and Petrology (3)
Geol 301	Introduction to Geophysics (3)
Geol 313	Sedimentation (3)
Geol 333	Crystallography (3)
Geol 341	Field Geology (6)

approved professional electives (10-15 credits)
Any courses approved by the adviser may be used to satisfy this requirement. The following are especially recommended:

Chem 31	Chemical Equilibria in Aqueous Systems (3)
EE 20	Introductory Circuit Theory (4)
Geol 63	Introduction to Oceanography (3)
Geol 306	Geophysical Field Techniques (3)
Geol 319	Regional Stratigraphy (3)
Geol 321	Statistical Applications (3)
Geol 334	Petrology and Petrography (4)
Geol 336	Mineral Phase Relations (3)
Geol 372	Principles of Geochemistry (3)
Geol 381	Meteorology (3)
Math 323	Methods of Applied Analysis (3)
Math 105	Computer Programming (3)
Math 302	Vector and Tensor Analysis (3)
Math 366	Programming Techniques (3)
Met 91	Elements of Materials Science (3)
Phys 216	Particles and Fields II (3)
Phys 340	Thermal Physics (3)
Phys 352	Modern Optics (3)
Phys 254	Optics Lab (2)
Phys 363	Physics of Solids (3)
Phys 365	Physics of Fluids (3)

GOVERNMENT

Professors. Donald D. Barry, Ph.D., chairman; Charles A. McCoy, Ph.D.; W. Ross Yates, Ph.D.

Associate professors. Frank T. Colon, Ph.D.; Howard R. Whitcomb, Ph.D.

Assistant professors. Carol Barner-Barry, Ph.D.; Laura Katz-Olson, Ph.D.; Edward P. Morgan, Ph.D.

The major in government is designed to promote understanding of political ideas, institutions and processes and to develop skills in analyzing and evaluating political problems.

These goals can best be achieved when a student is enabled to assume a large measure of responsibility for his or her own education. The student should be free to study in either structured or unstructured ways. The government department curriculum is designed so that the undergraduate can develop, with the approval of an adviser, a plan of course study in line with his or her interests, concerns and knowledge.

A balanced program within the discipline, one which exposes the student to various areas of inquiry in American institutions and political

processes as well as in the comparative and philosophical perspectives of political analysis, has been the way in which the goals of the major program generally have been achieved. While the major program outlined below will prove adequate for most student needs, it may be that because of some special factors such as late transfer or unusual interests and/or abilities the outlined program does not accommodate some students. In that case the students may, in consultation with their adviser, develop a major program which in their judgment will more adequately fulfill those needs.

The faculty adviser to the student majoring in the government department is designated by the department. The adviser consults with the student and approves his or her major program. The adviser attempts to help the student relate courses offered by the department to the student's educational goals. The adviser also may act as a resource for the student, and may suggest courses in other disciplines, language courses, and courses in research techniques which may be of benefit.

Completion of the government major is considered suitable training for the undergraduate who wishes to go on to law school, to become a social science teacher, or to work in such positions as governmental official, party or civic leader, public affairs commentator or staff member of a governmental research bureau. Graduate study is advisable for students comtemplating certain careers—college teaching, research, or public management, for example.

The following is the major program. Such a program should meet the needs of most students. However, deviations from this program, if requested by the student, may be approved by the adviser.

Core courses

Govt. 1	American Political System (3)
Govt 3	Comparative Politics (3)
Govt 102	Modern Political Heritage (3)
Govt 321	Methods for Political Research (3)

Electives

Seven elective courses with at least two courses from each of the following two fields:

American politics and public law

Govt 74	Political Parties (3)
Govt 77	Urban Politics (3)
Govt 79	The Politics of Women (3)
Govt 302	Comparative State Politics (3)
Govt 306	Public Policy Process (3)
Govt 317	The American Presidency (3)
Govt 325	Electoral Process (3)
Govt 327	Political Socialization (3)
Govt 328	The Politics of Urban Policy (3)
Govt 331	Urban Field Study (3)
Govt 351	Constitutional Law (3)
Govt 352	Civil Rights (3)
Govt 353	Law and Politics (3)
Govt 354	Administrative Law (3)
Govt 357	Technology Assessment (3)
Govt 358	Community and Regional Politics (3)
Govt 359	The Legislative Process (3)
Govt 360	Public Administration (3)

political theory and comparative politics

Govt 61	The Soviet Political System (3)
Govt 78	Political Behavior (3)
Govt 101	Classical Political Heritage (3)
Govt 106	Chinese Political System (3)
Govt 301	International Policy-Making (3)
Govt 305	The Dynamics of Regional Integration (3)
Govt 308	Ideologies in World Affairs (3)
Govt 318	Communist Political Systems (3)
Govt 322	Politics of Developing Nations (3)
Govt 324	Political Systems in Transition (3)
Govt 363	Contemporary Political Philosophy (3)
Govt 364	Issues in Contemporary Political Philosophy (3)
Govt 365	Political Values of Neo-Freudians and Existentialists (3)
Govt 368	Political Economy (3)

Urban Studies option in government
The government major is eligible to participate in the Urban Studies program, which is a multidisciplinary focus on the urban process. Interested students should refer to the section on Urban Studies.

Government minor
The minor consists of three of the four core courses listed above (Govt 1, Govt 3, Govt 102, and Govt 321) plus any two other government courses.

Public administration minor
The minor consists of Govt 1 and Govt 360 plus four other courses chosen in consultation with the adviser for a total of eighteen credit hours.

Undergraduate courses

1. American Political System (3) P fall-spring
Constitutional principles; organization and operation of the national government; the party system, citizenship, and civil rights.

3. Comparative Politics (3) P fall-spring
The political systems of foreign countries; approaches to the study of comparative politics.

61. The Soviet Political System (3) spring
The roles of the Communist Party, the Council of Ministers, the Supreme Soviet and other governmental and social organizations in governing the USSR. Mr. Barry.

74. Political Parties (3) P
Organization, function, behavior and effect of parties on the democratic process.

77. Urban Politics (3) P spring
The structure and processes of city government in the United States; city-state and federal-city relationships; the problems of metropolitan areas; political machines and community power structures; the urban politics of municipal reform; city planning and urban renewal. Mr. Morgan.

78. Political Behavior (3) P fall
Behavioral approaches to political science. Application to substantive topics and examples of current research.

79. The Politics of Women (3) P
Major social and political issues relating to the role of women in American society. Study of other countries will be included for comparative analysis. Ms. Katz-Olson.

101. Classical Political Heritage (3)
Significant political theorists from Plato to modern times.

Fig. 988.
HEAD AND FOOT OF BRAZILIAN EAGLE.

102. Modern Political Heritage (3)
Continuation of Govt 101, Classical political heritage. Utilitarianism, liberalism, socialism, idealism, positivism, etc.

106. The Chinese Political System (3)
Revolutionary origins of the Chinese political system. Roles of the state structure, Communist Party, army, mass organizations, and political campaigns in the political decision-making and policy implementation processes. Nature and function of Chinese political ideology.

For advanced undergraduates and graduates

301. (IR 301) International Policy-Making (3)
Policy-making processes in the contemporary world; impact of assumptions and projections of future social and technological change on international decisions. Prerequisite: IR 1 or 2 or consent of department chairman. Mr. Slouka.

302. Comparative State Politics (3) spring
Analysis of major questions relating to the role of the states in the American federal systems and their relationship with the national government. Mr. Colon.

305. (IR 305) Dynamics of Regional Integration (3)
Theories of regional integration; supranational community-building in West Europe, North Atlantic area, and developing countries in Latin America, Asia and Africa. Mr. Hodges.

306. Public Policy Process (3)
Power relations and their impacts on selected public policy, specifically taxation, housing, environment, poverty, energy, the military, and health. Ms. Katz-Olson.

308. (IR 308) Ideologies in World Affairs (3)
Role of ideologies in world affairs, emphasizing contemporary issues: nationalism and imperialism; European fascism and Japanese militarism; classical and Soviet Marxism-Leninism; thought of Mao Tse-tung; Third World ideologies and revolutionary movements; current ideological trends. Mr. Wylie.

313. Teaching Government (3)
Contemporary issues in the teaching of social studies in public and private schools, including those governmental decisions which affect the educational environment. The course focuses attention on a specific issue such as urban problems, comparative political systems, ideologies and American political institutions and processes. Designed primarily for secondary school teachers.

314. Workshop in Teaching Government (3)
Individual research projects on contemporary issues and discussion of proposals for curriculum revisions in the public and private schools. Outside speakers will be invited to attend workshop sessions. Must be taken concurrently with Govt 313 when courses are offered together.

317. The American Presidency (3)
Role of the executive in the American political process. Includes an analysis of the historical development, selection process, and scope of executive power. Ms. Katz-Olson.

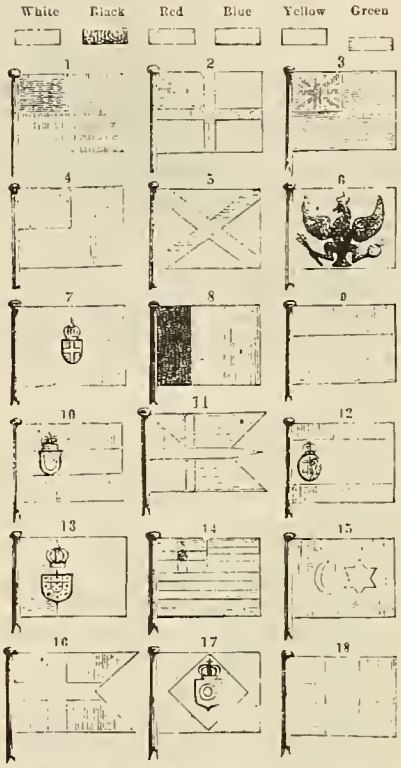

Fig. 1024.—FLAGS OF THE PRINCIPAL MARITIME NATIONS.

1, United States; 2, Britain, white ensign; 3, Britain, blue ensign; 4, Britain, red ensign; 5, Russia; 6, Prussia; 7, Italy; 8, Belgium; 9, Holland; 10, Austria; 11, Saxony; 12, Spain; 13, Portugal; 14, Greece; 15, Turkey; 16, Denmark; 17, Brazil; 18, France. (In these diagrams, the direction of the lines shows the color, as in heraldry.)

318. (IR 318) Communist Political Systems (3)
Examination of Communist political systems outside the USSR and the operations of nonruling Communist parties.

321. Methods for Political Research (3)
Introduction to research, research design (survey, experimental, aggregate), statistical and nonstatistical analysis, and computer applications.

322. (IR 322) Politics of Developing Nations (3)
Theories of political development in non-Western areas: modernization and nation building. Field studies and methods; contributions of related disciplines such as sociology and psychology.

324. (IR 324) Political Systems in Transition (3) spring
The responses of selected non-Communist states to contemporary problems. May be repeated for credit with consent of department chairman. Mr. Yates.

325. Electoral Process (3)
Public opinion, voting behavior, campaigns and elections.

327. Political Socialization (3)
The social, ideological and economic foundations of American politics. Emphasis on supporting institutions—family, schools, and work-place—and processes which foster political attitudes and behavioral patterns. Mr. Morgan.

328. The Politics of Urban Policy (3)
The interplay of political forces in selected urban policy areas. Readings, lectures and a class simulation to concentrate on the roots of urban poverty; school desegregation, community control, fiscal reform; and the political role of community groups, government agencies, the courts, and social science. Mr. Morgan.

331. Urban Field Study (3) fall-spring
Integrated classroom and fieldwork approach to the study of local government; includes an internship in a local governmental or private agency. May be repeated for credit. Prerequisite: consent of department chairman.

351. Constitutional Law (3) fall
The law of the Constitution as expounded by the Supreme Court of the United States. Nature and origins of judicial review, distribution and scope of governmental powers, and economic regulation in a federal system. Detailed consideration of judicial policy decision-making processes. Mr. Whitcomb.

352. Civil Rights (3) spring
A study of constitutional development in political and civil rights. Freedom of speech and of the press, religious freedom, due process of law and equal protection of the laws. Detailed consideration of constitutional issues concerning criminal procedure and racial discrimination. Mr. Whitcomb.

353. Law and Politics (3)
The techniques of legal-political analysis and the study of the uses of the legal process in the political sphere. A large part of the course will involve the examination of law and politics in the United States, but pertinent materials and examples from other countries will also be drawn on. Mr. Barry.

354. Administrative Law (3)
The authority, procedures, and methods used by executive agencies in the administration of public policy. Analysis of the general problem of adjusting the administrative process to traditional constitutional principles. Mr. Barry.

357. Technology Assessment (3)
Policy analysis of new and existing technologies in the United States; evaluation of societal consequences of technological decision-making and the identification of new alternatives in light of societal needs.

358. Community and Regional Politics (3)
Analysis of the changing political dimension of community in the context of regionalism. Attention directed to "the metropolitan problem."

359. The Legislative Process (3)
Organization and procedure of legislative and constituent assemblies. Legislative leadership. Role of administrative and judicial agencies in law-making. Pressure groups, parties, and policy determination. Direct legislation. Mr. Whitcomb.

360. Public Administration (3) spring
The nature of administration; problems of organization and management; public personnel policies; budgeting and budgetary systems; forms of administrative responsibility. Mr. Colon.

363. Contemporary Political Philosophy (3)
Continuation of Govt 102 with concentration on political philosophers after World War I.

364. Issues in Contemporary Political Philosophy (3)
Selected issues in contemporary political philosophy: such as political obligation and civil disobedience, participatory democracy and workers' control, "positivist" political analysis and the alleged decline of political philosophy. May be repeated for credit with consent of department chairman.

365. Political Values of Neo-Freudians and Existentialists (3)
The perspectives of Freud, Neo-Freudians such as Fromm and Marcuse, and existentialists such as Sartre and Camus. Mr. Yates.

366. The Politics of Education (3)
The political dimensions of the contemporary crisis in American education.

368. Political Economy (3)
Significance to democratic theory of the concentration of economic power and its interface with the polity.

371. Readings (3)
Readings in political science assigned to properly qualified students in consideration of their special interest in particular political institutions and practices. Prerequisite: consent of department chairman.

372. Readings (3)
Continuation of Govt 371. Prerequisite: consent of department chairman.

381, 382. Special Topics (3)
A seminar on a topic of special interest in a particular political institution process, or policy. Prerequisite: consent of department chairman.

For graduates

The department of government offers a graduate program leading to the doctor of arts (D.A.), the master of public administration (M.P.A.), and the master of arts (M.A.). The applicant for admission must demonstrate adequate undergraduate preparation, and may under certain circumstances be asked to submit Graduate Record Examination results.

Master of arts. The master of arts in government is a thirty-credit-hour program which can be accomplished in twelve months by full-time students. A comprehensive examination is required. The student may take twenty-four hours of course work and six hours of thesis or may take all thirty credit hours in course work.

The M.A. program is intended for the student with liberal arts or natural science preparation who has a professional interest in government. The M.A. may be a preparatory step toward doctoral work at another institution or a final degree preparatory for teaching in junior and community colleges or research positions in governmental, institutional or industrial settings.

Master of public administration. The master of public administration (M.P.A.) is a final degree emphasizing career preparation for governmental service. The program is designed to emphasize administration in all levels of governmental service—national, state, urban and municipal—and nongovernmental service in quasi-public and academic organizations.

The M.P.A. program consists of four parts:

1. core curriculum (12 credit hours).
The core curriculum consists of courses in public administration, legal foundations of public administration, governmental budgeting and public policy.

2. methodology and tools (six credit hours).
Tools in political research, evaluation and survey techniques are required. These courses may be chosen from courses offered in the government or social relations departments. Also, a basic proficiency in accounting is required.

3. the general public administration/urban concentration option (nine credit hours).
The student has the option of selecting a general program in public administration or one with an urban concentration. These electives, chosen in consultation with an adviser, may include courses from a number of departments such as government, economics, history, management, and social relations.

4. Internship (three credit hours)
This will be a specially arranged program. A thesis-level essay could be substituted if an internship were not considered necessary.

The final requirement is a comprehensive examination.

Doctor of arts. The D.A. program is designed for students holding the bachelor's or master's degree who wish to prepare for a career in college teaching of political science. In every respect, the evaluation standards are equal to those of a Ph.D. program. Guidelines developed by the Council of Graduate Schools and American Association of State Colleges and Universities have been followed in planning this program.

The D.A. program differs from the Ph.D. program in a. the requirement of a broader distribution of graduate courses in government; b. a minor area of study for those students who wish to have bidisciplinary preparation for two-year college teaching; c. course work and training in interpersonal awareness; d. a general examination tailored to the D.A.; e. a project of applied research rather than a dissertation, and f. supervised internships.

The student entering will follow one of three tracks, depending on whether he or she is 1. beginning graduate work; 2. transferring up to thirty credit hours for a M.A. in political science; or 3. transferring up to thirty credit hours for an M.A. in a cognate field.

As currently structured, it is possible for the student entering with a bachelor of arts to complete the program in three years of full-time study. The full-time student entering with an M.A., either in political science or in a cognate field, can complete it in two years.

The doctor of arts program consists of four parts: a core concentration in interpersonal awareness and teaching; a concentration in political science; a minor in a cognate field; teaching and community internships and a project.

the core curriculum (15 credit hours)
interpersonal awareness (3)
teaching government (3)
research methods (3)
electives (6)

political science concentration (33-45 credits)
Students entering the program with a B.A. or an M.A. in a cognate field take thirty-three credit hours in political science; those entering with an M.A. in political science will be required to take fifteen credit hours at Lehigh in addition to the amount transferred.

The department requires general examinations in two of the following three fields: American Politics, Comparative Politics-International Relations, and Political Theory. However, one of these is to be designated by the student as the major field, the other as the minor. Moreover, the student may indicate an area of major emphasis, e.g., American—Public Administration.

The student registers for 400-level (graduate seminars) courses where appropriate and it is expected that all students take at least one seminar at Lehigh in each of the three fields identified above.

cognate minor (12 credit hours)
On the basis of interest and undergraduate education, students are encouraged to select their minor from a wide range of subject areas including both the natural and social sciences. Where possible this is related to the internship experience of the student. Associated with the department of government are the departments of social relations, and history, and the division of urban studies.

Students entering Lehigh with an M.A. in a cognate field may be excused from all course work in this area; however, they are still required to take the general examination in their cognate minor.

internships and project (12-30 credit hours)
The course credit allocated to the internships and project will vary from twelve credit hours for the student who transfers with an M.A. in a

cognate field, to thirty credit hours for the student who enters the program with a bachelor of arts degree. Regardless of the credits allocated, the standards for the internships and project are identical.

Students participate in an evaluated, supervised, part-time teaching internship either at the junior or four-year college level for one semester.

Students also participate in a community organization internship on a part-time basis. The purpose of this internship is to sensitize them to a broad range of social and political problems in the larger society.

The students complete a project of applied research of a pedagogical nature which is the functional equivalent of the dissertation in a Ph.D. program. Ideally, it should integrate internship experiences.

examination

Those students entering the doctor of arts program without the master's degree in political science will be required to take a continuing proficiency examination prior to their second year of study.

The general examination is taken prior to the commencement of the student's project. It consists of three parts as noted earlier: an examination in the cognate minor, and in the major and minor in the political science concentration. The examination is both written and oral.

The student is required to defend the completed project before the doctoral committee.

Graduate courses

401. Comparative State Politics (3)
The role of the states is analyzed within the American federal system. Emphasis is placed on the functions and policies of states and their relations with the national government. Mr. Colon.

403. The American Polity (3)
Integrative overview of the American polity's emphasis on national institutions: presidency, Congress, judiciary, party systems and their interrelations.

405. The Budgetary Process (3)
The public budgetary process: competition among interest groups, policy outcomes, intergovernmental relations, and consequences for policy implementation.

407. American Constitutional Development (3)
The law of the Constitution as expounded by the Supreme Court of the United States. Nature and origins of judicial review, institutional aspects of separation of powers and federalism, economic regulation in a federal system, and political and civil rights. Detailed consideration of judicial policy-making processes and judicial biography. Mr. Whitcomb.

409. Comparative Administrative Systems (3)
Problems of governmental organization and administration; the administration of public services in selected countries; comparison of administrative procedures in various jurisdictions or political systems with those in the United States.

411. The Legal Foundations of Public Administration (3)
The authority, procedures, and methods used by executive agencies in the administration of public policy and the general problem of adjusting the administrative process to traditional constitutional and legal principles. Mr. Barry.

413. Modern Political Philosophy (3)
A study of selected modern political philosophers and their continuing effect on politics and political philosophy. Mr. Yates.

414. Contemporary Political Philosophy (3)
Selected contemporary political philosophers and their responses to conditions of contemporary political life.

421. Research Methods (3)
Research approaches, design techniques, statistical and nonstatistical analysis, and computer applications.

424. Administrative Theory (3)
Administrative theory and practice in both the public and nonpublic sphere in the United States; model building and field research emphasizing the concepts of public and private administrative systems. Mr. Colon.

431. Public Administration (3)
The sutdy of bureaucracy and the problems of public organization and management; executive leadership; personnel, budgeting and regulatory administration. Mr. Colon.

432. Public Policy Process (3)
Impacts of power relationships on selected public policy areas such as the military, agriculture, housing, environment, energy, poverty, health, and taxation. May be repeated for credit. Ms. Katz-Olson.

434. Field Work in Political Science Application (3)
Internship in private or public civic agency. Primarily for doctor of arts students. May be repeated for credit.

443. Law and Social Policy (3)
The role of law in the development of social policy. Emphasis on judicial and administrative rather than legislative processes. Substantive areas vary from semester to semester; some of the topics are: judicial administration, administrative regulation, law and social change, and foreign legal systems. May be repeated for credit.

451. Comparative Politics (3)
Theory and concepts in comparative politics. Analysis of various applications in studies of Western and non-Western political systems.

460. Urban Policy (3)
Politics of urban policy areas; welfare, education, housing, transportation, crime, employment, and health. Mr. Morgan.

461. Community Power Structure (3)
A focus on power relations and decision-making on the community level. Special attention given to theories of community power.

471. Seminar in Teaching Government (3)
Theories and techniques of instruction, learning, evaluation, instructional design on innovation in the teaching of government. Prerequisite: doctor of arts candidacy or permission of the department chairman.

472. Workshop in Teaching Government (3)
Directed experience in teaching and instructional design of lower division government courses.

481. Special Topics (3)
Individual inquiry into some problems of government. Reading, field work, and other appropriate techniques of investigation. Conferences and reports. May be repeated for credit.

482. Special Topics (3)
Continuation of Govt 481.

URBAN STUDIES

Associate professors. Frank T. Colon, Ph.D., head; Carlos Alvare, M. Arch., M.C.P.; James R. McIntosh, Ph.D.; Warren Pillsbury, Ph.D.
Assistant professor. Roger Simon, Ph.D.
Lecturer. David C. Amidon, Jr., M.A.

Undergraduate major

This is an interdepartmental major program intended for students who seek a broad background in the social sciences and for those with career interests in such fields as city management, architecture and urban planning, human relations, and the helping professions (social welfare and rehabilitation).

Instruction focuses on the process of urbanization, the problems and opportunities arising therefrom, analytical methods and insights which have been developed by students of urbanization, and existing and proposed public policies relating to cities.

Undergraduates interested in the major should call the department of government to arrange an appointment with the adviser of the division of urban studies. A minimum of forty-two credit hours is required, apportioned among three levels of study. Substitutions are possible with approval of the program head. No course can be used to satisfy requirements at more than one level.

I. required preliminary courses (9 credit hours)

US 61	The Study of Urbanization (3)
US 62	Contemporary Urban Issues (3)

One of the following four research methods courses:

SR 211	Integrated Study of Social Relations
Govt 321	Methods for Political Research (3)
Hist 395	Quantitative Methods in Historical Studies (3)
Eco 45	Statistical Method (3)

II. required core courses (18 or 19 credit hours)
choice of three of the following five sequences

economics sequence

Eco 1	Economics (4)
Eco 312	Urban Economics (3)

fine arts sequence

FA 151	History of Urban Design (3)
FA 152	Physical Planning and Design (3)

government sequence

Govt 77 Urban Politics (3)

and any one of these

Govt 331 Urban Field Study (3)
Govt 358 Community & Regional Politics (3)
Govt 360 Public Administration (3)

history sequence

Hist 333 American Urban History to 1880 (3)
Hist 334 American Urban History, 1880 to Present (3)

social relations sequence (any two of these)

SR 211 Integrated Study of Social Relations (3)
SR 212 may be substituted if SR 211 has been used to satisfy the research methods preliminary requirement above.
SR 320 Urban Ethnology (3)
SR 368 The Urban Community (3)

III. area option courses (15 or more credit hours)

One of the following four area options must be elected for a minimum of five courses yielding at least fifteen credit hours.

A. urban management option (15 credit hours)
prerequisites: three core sequences above, including economics and government

Acctg 108 Fundamentals of Accounting (3)
Eco 337 Transportation and Spatial Economics (3)
Eco 354 Public Finance: State and Local (3)
Govt 331 Urban Field Study (3)
Govt 354 Administrative Law (3)
Govt 360 Public Administration (3)
Mgt 321 Business and Organizational Behavior (3)

B. urban design option (15 credit hours)
prerequisites: three core sequences above, including fine arts and history

Eco 337 Transportation and Spatial Economics (3)
FA 43 Environmental Design (3)
FA 143 Environmental Planning and Project (3)
FA 144 Intermediate Environmental Design (3)
FA 200 20th-Century Architecture (3)
CE 13 Civil Engineering Concepts (3)
CE 106 Structural Design (3)

C. social science option (15 credit hours)
prerequisites: three core sequences above, chosen from government, history, social relations, and economics; courses not offered to satisfy the core sequences requirement may be included below.

Eco 337 Transportation and Spatial Economics (3)
Eco 354 Public Finance: State and Local (3)
Govt 306 Public Policy Process (3)
Govt 354 Administrative Law (3)
Hist 326 American Social History Since 1877 (3)
Hist 331 The Negro in America (3)
Hist 333 American Urban History to 1880 (3)
Hist 334 American Urban History 1880 to Present (3)
Hist 339 History of Public Health (3)
Latin 204 The Ancient City (3)
SR 75 The Minority Groups (3)
SR 151 Utopias and Alternative Communities (3)
FA 151 History of Urban Design (3)

Fig. 1986. — OLDENBURG.

US 363 Philadelphia: Development of a Metropolis (3)
US 365 Lehigh Valley: Development of a Regional Center (3)

or up to two additional urban studies courses (0-6)

D. human relations option (15 credit hours)
prerequisites: three core sequences above, including government and social relations. Of the total of fifteen credit hours for this option, at least six credit hours must be elected from among the courses in each group below:

cultural groups

Hist 331 The Negro in America (3)
SR 75 Minority Groups (3)
SR 320 Urban Ethnology (3)
US 125 American Ethnic Groups (3)
US 321 White Protestant Americans (3)
US 324 The Irish in American Society (3)
US 326 The American Italian Community (3)
US 328 The American Jewish Community (3)
Engl 312 Jewish Literature (3)
Engl 319 The Black in American Literature (3)
German 233 Pennsylvania German Culture (3)
RS 151 The Jewish-Christian Encounter (3)
RS 154 The Holocaust (3)
Hist 325 American Social History 1607-1877
Hist 326 American Social History Since 1877

professional concepts

Govt 331 Urban Field Study (3)
Govt 352 Civil Rights (3)
Govt 360 Public Administration (3)
SR 307 Attitudes and Social Influence (3)
SR 308 Seminar in Social Psychology (3)
SR 312 Interpersonal Behavior in Small Groups (3)
SR 361 Social Conflict (3)
IS 302 Psycholinguistics (3)

Note that six credit hours in the professional concepts category toward the human relations option will be allowed students who complete a major program in social welfare education through the Lehigh Valley Association of Independent Colleges, provided major credit is not also claimed for Govt 331.

Urban Studies minor

The minor consists of US 61, up to two additional urban studies courses, plus any three courses from an approved list for a total of eighteen credit hours.

Undergraduate courses

61. The Study of Urbanization (3) fall
Analyses of the city from early historical speculations to current behavioral studies.

62. Contemporary Urban Issues (3) spring
Review of the literature on urban issues: poverty, law enforcement, race relations, planning and education.

125. American Ethnic Groups (3) fall 1978
Immigration to the United States; persistence of

Fig. 588.—THE GREAT WALL OF CHINA.

cultural differences over generations; patterns of conflict and accommodation; assimilation; ethnic politics; emphasis on white Euro-American nationality groups, with some attention to Afro-, Hispano-, Asian- and Native Americans. Mr. Amidon.

321. White Protestant Americans (3) fall 1977
Cultural and religious origins of the historically dominant ethnic group in the United States: rise and decline of a national Anglo-Protestant urban elite; persistence of regional and nonelite subcultures; "Wasp" sterotypes and anti-Protestant themes in American culture. Mr. Amidon.

324. The Irish in American Society (3) spring 1979
Cultural, economic and political experience of a major white ethnic group in the United States: Irish Catholics vs. Scotch-Irish Protestants; immigrant poverty; priests and prelates, ward heelers and big-city bosses; Irish themes in American literature, humor and media culture; Irish radicalism. Mr. Amidon.

326. The American Italian Community (3) spring 1978
European background of Italian emigration; patterns of first-generation experience in the United States; distinctive values, folkways and institutions; the "Mafia"; political behavior; upward mobility and assimilation; achievements of outstanding individuals, interaction with general American culture. Mr. Amidon.

328. The American Jewish Community (3) spring
Historical and sociological perspectives on the experience of an important minority in the United States; communal institutions and social patterns; orientation toward achievement and secular success; Jewish influences in American culture; anti-Semitism, acceptance, and survival as a distinct subculture. Mr. Amidon.

363. Philadelphia: Development of a Metropolis (3) fall
Philadelphia as an early experiment in the deliberate creation of a new community; the rise of the port; industrialization and immigration; creation of a hinterland and competition with rival centers; upper-class family continuity; religious life and institutions; political history; the Afro-American experience and the black impact on Philadelphia; "planning".

365. Lehigh Valley: Development of a Regional Center (3) summer
Analysis of the growth and character of regional centers ("provincial towns") in general; geography of the Lehigh Valley; development of the economic, cultural and political characteristics of this area; public policy in such areas as economic development, physical planning, social welfare and human relations. Primarily for summer session, but may occasionally replace US 363 in the fall.

371, 372. Special Topics (3 each)
A seminar on a topic of special interest in urban studies. Prerequisite: consent of the division head.

For graduates

An urban studies option is offered under the master of public administration (MPA) degree which is administered by the department of government.

HISTORY

Professors. Lawrence H. Leder, Ph.D., chairman; Joseph A. Dowling, Ph.D., distinguished professor; John McV. Haight, Jr., Ph.D.; William G. Shade, Ph.D.; Charles L. Tipton, Ph.D.

Adjunct professor. Winfred Kohls, Ph.D.

Associate professors. George M. Ellis, Ph.D.; John H. Ellis, Ph.D.; James S. Saeger, Ph.D.

Assistant professors. Michael Baylor, Ph.D.; Ian P. H. Duffy, D. Phil.; Roger D. Simon, Ph.D.

History is the study of human activities. As such, it encompasses not only events and public policy, but the whole sweep of cultural achievements—religion and philosophy, literature and art, economic and social life. Some of the most influential thinkers and public people of our time (Toynbee, Kennan, Churchill, Kennedy, among others) have studied contemporary problems by viewing the forces in the past which have shaped our world.

Students take courses in three culture areas, examining major developments in each in terms of cause and effect, the historians' main concern. These courses provide training in research, analysis of historical problems, and formulation of historical judgments, as well as in writing. History majors have the foundation for law school, government service, journalism, teaching, and graduate study.

Honors study in history is by invitation of the department in the student's junior year. The student must attain an average of 3.25 in history courses, and must demonstrate a special competence in history. Those interested in honors work are urged to consult the department chairman early in their junior year.

Honors students in history may plan special programs, including more in-depth study of two culture areas rather than three. They enroll for three hours credit of unrostered history as part of their thirty-nine hours and complete in that course an honors thesis.

distribution requirements

A history major meets the following distribution requirements and the major totals thirty-nine hours:

Hist 1, 2
Maximum of twelve hours in courses below 100
Minimum of twelve hours in courses numbered above 200, not including Hist 201 and 395
Hist 201 or 395
Maximum of eighteen hours of courses from any one group, and minimum of three hours from each group listed below.

Group A courses

Hist 5	The Machine in America to 1900 (3)
Hist 6	The Machine in Modern America (3)
Hist 8	Medicine and Society in America (3)
Hist 9	Formation of American Society (4)
Hist 10	American Society in the Industrial Era (4)
Hist 119	Colonial America (3)
Hist 120	Revolutionary America (3)
Hist 135	United States, 1789-1840 (3)
Hist 136	United States, 1840-1877 (3)

Hist 137	United States, 1877-1920 (3)
Hist 138	United States, 1920 to Present (3)
Hist 153	Religions and the American Experience (3)
Hist 322	American Economic History (3)
Hist 325	American Social History, 1607-1877 (3)
Hist 326	American Social History Since 1877 (3)
Hist 327	American Intellectual History (3)
Hist 328	American Intellectual History (3)
Hist 329	American Foreign Policy (3)
Hist 330	Modern American Foreign Policy (3)
Hist 331	The Negro in America (3)
Hist 332	Oral History (3)
Hist 333	American Urban History to 1880 (3)
Hist 334	American Urban History, 1880 to the Present (3)
Hist 338	Psychohistory (3)
Hist 341	Development of Federal Science Policy (3)
Hist 342	The American Engineer (3)
Hist 374	Themes in American History (3)

Group B courses

Hist 15	English History (3)
Hist 16	English History (3)
Hist 21	Ancient History (3)
Hist 22	Ancient History (3)
Hist 149	Barbarian West (3)
Hist 150	Medieval Civilization (3)
Hist 154	The Holocaust: History and Meaning (3)
Hist 157	The Renaissance and Reformation (3)
Hist 158	Age of the Baroque (3)
Hist 159	Modern Europe (3)
Hist 160	Modern Europe (3)
Hist 267	The Iberian Peninsula (3)
Hist 339	History of Public Health (3)
Hist 340	History of Medicine (3)
Hist 343	English History, 1471-1660 (3)
Hist 344	English History, 1660-1789 (3)
Hist 345	Liberal England (3)
Hist 346	Socialist England (3)
Hist 347	English Constitutional and Legal History to 1485 (3)
Hist 348	English Constitutional and Legal History Since 1485 (3)
Hist 351	Conservatism in the Modern Age (3)
Hist 355	European Intellectual History (3)
Hist 356	European Intellectual History (3)
Hist 357	France, 1715-1848 (3)
Hist 358	France, 1848 to Present (3)
Hist 361	A History of Russia to 1855 (3)
Hist 362	A History of Russia, 1855 to Present (3)
Hist 363	Modern Germany, 1618-1848 (3)
Hist 364	Modern Germany, 1848 to Present (3)

Group C courses

Hist 4	Chinese Civilization (3)
Hist 49	History of Latin America (3)
Hist 50	History of Latin America (3)
Hist 265	Mexico and the Caribbean (3)
Hist 266	Argentina, Brazil and Chile (3)
Hist 368	Seminar in Latin American History (3

Hist 51, 52, 300, 371, 372, or provisional courses will be placed in one of the above groups in accordance with their contents and emphases.

History majors are encouraged to enroll in courses in economics, English and American literature, government, international relations, philosophy, psychology, religion studies, and social relations. Students intending to do graduate work should acquire a reading knowledge of at least one foreign language, choosing languages appropriate to their area of concentration.

Minor programs in history

A student may establish a minor program in history which covers either a geographical, topical, or chronological interest (American, European, technological and medical, or 20th-century history, to mention a few possibilities). Each student's minor program must be prepared in consultation with the history department chairman, must total at least fifteen hours and must conform to the following pattern:

Six hours in courses numbered below 100
Maximum of six hours in 100 level courses
Mimimum of three hours in courses numbered above 200

Undergraduate courses

1. Course of Civilizations (3) P fall
Civilizations in the East, West and Africa from earliest times to 1700. Mr. Haight.

2. Course of Civilizations (3) P spring
Civilizations in the East, West, and Africa from 1700 to the present. Mr. Haight.

4. Chinese Civilization (3) P spring
Institutional, social and intellectual development of traditional China, and its transformation in the 19th- and 20th-centuries.

5. The Machine in America to 1900 (3) P fall
Social history of American technology from the 17th-century to 1900; the transplantation of a medieval technology and its displacement by a modern, industrial technology.

6. The Machine in Modern America (3) P spring
The rapid intrusion of science into many areas of American life and the consequent changes in traditional technologies.

8. Medicine and Society in America (3) P
Historical perspectives on values, ideas, and practices in American medicine. Mr. J.H. Ellis.

9. Formation of American Society. (4) P fall
Social, economic, cultural and political institutions through Reconstruction, emphasizing their effects on public policy and culture.

10. American Society in the Industrial Era (4) P spring
Continuation of Hist 9, emphasizing the impact of industrialization on public policy, thought and social structure.

15. English History (3) P fall
The history of England to 1688. The origins of representative government, the development of English social institutions, the unification of England, and the Renaissance and Reformation in England. Mr. Duffy.

16. English History (3) P spring
English political and social institutions from 1688 to the present. The evolution of parliamentary government, the rise of modern parties, the industrial revolution, and recent social philosophies. Mr. Duffy.

21. (Greek 21) Ancient History (3) P
The development of civilization from palaeolithic times to the world empire of Alexander the Great. The social, economic, religious, philosophic, artistic, and literary development of the ancient world; the origin of political institutions. Mr. Maurer.

22. (Latin 22) Ancient History (3) P
Continuation of Greek 21. The Hellenistic Age. Rome from its origin to 395 A.D. Mr. Maurer.

49. History of Latin America (3) P fall
Spanish and Portuguese colonization of America and the struggles for independence, preceded by a brief view of the ancient American civilizations and the Iberian backgrounds. Mr. Saeger.

50. History of Latin America (3) P spring
Continuation of Hist 49. The development of the Latin American nations in the 19th and 20th centuries. Mr. Saeger.

51. Freshman Seminar (3) P
An intensive analysis of a particular period, problem or area of history, emphasizing readings, discussions, and reports. The topics and instructor will vary each semester. Open by invitation to students with advanced placement credit in history or equivalent background, or upon application to the chairman of the department.

52. Freshman Seminar (3) P
A continuation of Hist 51.

119. Colonial America (3) fall
Founding and growth of colonies in North America through c. 1750. Attention will be paid to motives behind European expansion as well as to developments in the colonies. Mr. Leder.

120. Revolutionary America (3) spring
American political, economic and cultural development from the mid-18th century through the adoption of the Federal Constitution. Mr. Leder.

135. United States, 1789-1840 (3)
The American political system from the Constitution through Jacksonianism. Special emphasis upon the first and second party systems and the democratization of American political culture. Mr. Shade.

136. United States, 1840-1877 (3)
Civil War and Reconstruction, emphasizing the causes of the Civil War, its impact upon American society and politics, and problems of postwar reconstruction. Mr. Shade.

137. United States, 1877-1920 (3)
Political, economic, and social responses to industrial America. The rise of the Populist and Progressive movements, coming of World War I, and postwar developments. Mr. Simon.

138. United States, 1920 to Present (3)
American institutions in the modern era, emphasizing critical changes of the 1920s, the Crash of 1929, the New Deal, World War II, and later political, social and economic events. Mr. Dowling.

149. The Barbarian West (3) fall
Merger of Greco-Roman, Germanic, and Christian institutions and culture in Western Europe to mid-11th century. Evolution of the church, feudalism, and manorialism, and the foundations of the Carolingian and Holy Roman empires. Mr. Tipton.

150. Medieval Civilization (3) spring
Formation and development of western culture to about 1400. Rise of universities and towns, legal development and origins of representative government, origins of nation-states, scholasticism and decline of the medieval church. Mr. Tipton.

153. (RS 153) Religion and the American Experience (3) fall
The historical development of major religious groups in this country from colonial times to the present. Their place in social and political life, and the impact of the national experience upon them. Emphasis on religious freedom and pluralism, and the church-state relationship. Mrs. Eckardt.

154. (RS 154). The Holocaust: History and Meaning (3) spring
The Nazi holocaust in its historical, political and religious setting. Emphasis upon the moral, cultural and theological issues raised by the Holocaust. Mrs. Eckardt.

157. The Renaissance and Reformation (3) fall
The transition from medieval to modern society. Consideration of political, economic and social forces produced by the Renaissance and their influence upon the dominant religious theme of the Reformation era. Mr. Baylor.

158. Age of the Baroque (3) spring
Developments in 17th-and 18th-century Europe which made it a major pre-industrial civilization. Mr. Baylor.

159. Modern Europe (3) fall
Revolutions and reactions in Western Europe from 1789 to 1870. The rise and spread of liberalism and the origins of socialism. Mr. Haight.

160. Modern Europe (3) spring
Contemporary Europe; the origins and consequences of two world wars; the rise of revolutionary governments in Italy, Germany and Russia. Mr. Haight.

For advanced undergraduates and graduates

201. Historical Perspectives (3) spring
Methodologies and interpretations of Western historians from ancient times to the present. Mr. Tipton.

265. Mexico and the Caribbean (3)
Emphasis on Mexico and Cuba from the era of Bourbon reforms through the wars of independence to the 20th-century revolutions. Mr. Saeger.

266. Argentina, Brazil and Chile (3)
Eighteenth-century Spanish imperial readjustments, independence, the emergence of new societies, 20th-century extremist movements, and the problems of developing nations. Prerequisite: consent of department chairman. Mr. Saeger.

267. The Iberian Peninsula (3)
Rise and fall of Spain and Portugal as European and colonial great powers in the early modern period; their development after the Industrial Revolution; emphasis on Spanish Civil War (1936-39). Mr. Saeger.

300. Apprentice Teaching (3)

322. American Economic History (3)
Economic development since the colonial period, emphasizing the rapid industrialization from 1820 to 1890 and the social impact of economic change. Mr. Simon.

325. (SR 325) American Social History, 1607-1877 (3) fall
Social change from early agrarian communities to beginnings of industrialism, emphasizing socio-economic class, family structure, and treatment of women and minority groups.

326. (SR 326) American Social History Since 1877 (3) spring
Changing role of women, minorities, and the family during the industrial era. Development of the modern class structure and the impact of the welfare state.

327. American Intellectual History (3) fall
Development of political, social, and religious ideas in America from the colonial period to the Civil War. Mr. Dowling.

328. American Intellectual History (3) spring
Economic, political, and religious thought in industrial America, 1860 to the present. Mr. Dowling.

329. American Foreign Policy (3)
Late 18th-century origins of American diplomatic ideas, their development and application through the 19th century. Mr. Leder.

330. Modern American Foreign Policy (3)
The United States in world affairs from the late 19th century to the present; the testing and revision of traditional ideas in the face of changing needs and responsibilities. Mr. Saeger.

331. The Negro in America (3)
Negro subculture in America from the colonial period to the present, emphasizing the struggle for emancipation and equal rights. Topics include: racialism, slavery, Reconstruction, urbanization, protest movements, and the "Second Reconstruction." Mr. J.H. Ellis.

332. Oral History (3)
Capturing historical data through recorded interviews with individuals who have lived through or participated in significant events. Emphasis on students' techniques in conducting interviews. Themes vary. Equipment and materials loaned by department. Mr. Simon.

333. American Urban History to 1880 (3) fall
Planning and design of colonial and frontier cities. Impact of transportation innovations and industrialization, emergence of a national system of cities. Internal problems of early industrial cities: housing, transportation, public health, crime, social mobility. Mr. Simon.

334. American Urban History, 1880 to Present (3) spring
Physical expansion of the industrial city and its relationship to current urban problems. Suburbanization, development of the central business district, reforms in housing and public health, rise of ghettoes, emergence of the city planning profession and the idea of "new towns," impact of the New Deal and "urban renewal." Mr. Simon.

338. Psychohistory (3) spring
Uses of psychology in history and biography; exploration of problems of methodology, verification of evidence, conceptual frameworks and theories of personality; potentialities and limitations of psychological investigation as an historical technique. Mr. Dowling.

339. History of Public Health (3) fall
Ideas and major institutional developments concerning health and disease from ancient times to the present. Mr. J.H. Ellis.

340. History of Medicine (3) spring
Ideas and major developments in the theory and practice of medicine from ancient times to the present. Mr. J.H. Ellis.

341. Development of Federal Science Policy (3)
Institutional origins and evolution of federal science policy from the early republic to the present, emphasizing the period since 1939.

342. The American Engineer (3)
Social history of the development of an engineering profession from the early republic to the present.

343. English History, 1471-1660 (3) fall
England under the Tudor monarchy and the problems facing its successors culminating in the civil wars and Interregnum. Political, economic, intellectual and religious developments of the period. Mr. G.M. Ellis.

344. English History, 1660-1789 (3) spring
Constitutional monarchy from the Stuart Restoration to the French Revolution. English civilization in an age of oligarchy, especially the political, social, economic and intellectual sectors. Mr. G.M. Ellis.

345. Liberal England (3) fall
Political and social history, 1790-1870; transition from aristocracy to democracy; the influence of the utilitarians; radical reforms and reactions; the impact of the industrial and agricultural revolutions. Mr. Duffy.

346. Socialist England (3) spring
Political and social history, 1870-1970; the expansion of democracy; the growth of the Labor Party; the impact of the second industrial revolution; the making of the welfare state; the consequence of two world wars. Mr. Duffy.

347. English Constitutional and Legal History to 1485 (3) fall
Origins and development of government, administration, and law from Anglo-Saxon times to 1485, emphasizing common law institutions, practices, and procedures. Mr. Tipton.

348. English Constitutional and Legal History Since 1485 (3) spring
Emphasis on development and problems of sovereignty, constitutional monarchy, the cabinet system, and legal and administrative changes in the modern era. Mr. Duffy.

351. Conservatism in the Modern Age (3)
Conservative political, economic, and social thought from the 18th century to the present. Mr. Tipton.

355. European Intellectual History (3) fall
Political and religious thought and other aspects

Fig. 2196.
PYTHON, OR ROCK-SNAKE, (*Hortulia natalensis.*)

of the history of ideas in Europe from the Middle Ages to about 1700. Mr. Baylor.

356. European Intellectual History (3) spring
A continuation of Hist 355, with special attention given to the impact of the industrial revolution upon the development of 19th and 20th-century ideologies. Mr. Baylor.

357. (French 357) France, 1715-1848 (3)
Interrelation of politics, economics, social forces, and culture from Louis XV through the Revolution of 1848. Mr. Haight.

358. (French 358) France, 1848 to Present (3)
Interrelation of politics, economics, social forces, and culture from the Revolution of 1848. Mr. Haight.

361. A History of Russia to 1855 (3) fall
Major cultural, social, and political traditions of the Russian people. Mr. Kohls.

362. A History of Russia, 1855 to Present (3) spring
The Great Reforms, collapse of Tsarist absolutism, revolution of 1917, and formation and consolidation of the Soviet dictatorship. Mr. Kohls.

363. Modern Germany, 1618-1848 (3) fall
Political, socio-economic, and cultural developments from the age of triumphant absolutism to the failure of liberalism. Mr. Baylor.

364. Modern Germany, 1848 to Present (3) spring
Political history from the Second Empire to the federal and socialist republics. Twentieth-century intellectual and social problems. Mr. Baylor.

368. Seminar in Latin American History (3)
Readings and individual investigation of selected topics. Mr. Saeger.

371. Special Topics in History (1-3)
Intensive study in an area of history not adequately covered in currently listed offerings. The course may be administered as a reading program or otherwise as may seem best to meet the needs of students of unusual ability and adequate preparation. Prerequisite: consent of department chairman.

372. Special Topics in History (1-3)
Continuation of Hist 371. Prerequisite: consent of department chairman.

374. Themes in American History (3)
An intensive study of a selected topic in American history primarily for American Studies majors. The topic may vary from time to time as the needs of the American Studies program dictate. The seminar allows study of an aspect of American history in greater depth than is generally the case. Prerequisite: permission of the director of American Studies. Mr. Dowling.

395. Quantitative Methods in Historical Studies (3) spring
Historical uses and methods of quantitative analysis, including the application of descriptive statistics, statistical inference, and computer technology to a variety of problems drawn from European, American and Latin American history. Mr. Shade.

For graduates

Linderman Library is especially rich in materials for advanced study and research in history, and the department of history offers programs leading to master of arts and doctor of philosophy degrees. Graduate programs provide intensive and specialized study, and limited enrollment maintains close relations between faculty and students.

Admission to graduate study in history is competitive and dependent upon the applicant's undergraduate preparation and record, recommendations, and Graduate Record Examination scores. Besides general requirements for the Graduate School, the following special requirements apply to graduate study in history.

Master of Arts. There are two masters programs. Under plan I, a candidate may earn the degree by successfully completing twenty-four hours of approved course work and submitting a satisfactory thesis. Those continuing toward a doctorate must elect Plan I. Candidates declaring Plan II do not write a thesis, but take thirty hours of course work in and pass examinations in two fields chosen from American, British, European and Latin American history. Master's candidates must maintain a 3.0 average in all graduate work.

Doctor of Philosophy. Candidates for the doctor of philosophy in history must maintain a 3.25 history average and a 3.0 over-all average on all graduate work taken at Lehigh or elsewhere.

Students entering with a master's degree take a qualifying examination before beginning their second semester at Lehigh. During their second semester at Lehigh doctoral students select four history fields and one outside field and prepare themselves for written and oral examinations in those fields. Course work is required in a fifth history field, but it will not covered in the comprehensive examinations. An original dissertation is required and may be written only in a primary field.

Primary fields. Primary fields are Great Britain, Colonial America, 19th-Century America, and 20th-Century America.

Other fields. Other fields of specialization are Medieval-Renaissance, Modern Europe to 1789, Modern Europe Since 1789, and Latin America.

Language requirements. The qualifying examination in one language must be passed before beginning course work beyond the master's degree in order that the language may be used in doctoral course work. The candidate's special committee, appointed by the chairman of the department, will designate any additional languages for the student if needed. Languages will normally be chosen from among French, Spanish, Italian, German and Russian.

All graduate majors must take Hist 401.

401. Methods in Historical Research (3) fall
Techniques of research in history; training in the critical handling of documentary materials, in measuring the value of evidence, and in formal presentation of the results of research. Required of all graduate students in history. Mr. Tipton.

404. Historiography: Europe (3)
The approach, methods and interpretations of the leading historians of Europe.

405. Historiography: America (3)
The approach, methods and interpretations of the leading historians of America.

442. Readings in American History (3)
Study in small groups under the guidance of a faculty member of the literature of a particular period, problem, or aspect of American history. May be repeated for credit with permission of department chairman.

443. Readings in English History (3)
Study in small groups under the guidance of a faculty member of the literature of a particular period, problem, or area of English history. May be repeated for credit with permission of department chairman.

444. Readings in Latin American History (3)
Study in small groups under the guidance of a faculty member of the literature of a particular period, problem, or area of Latin American history. May be repeated for credit with permission of department chairman.

447. Readings in European History (3)
Study in small groups under the guidance of a faculty member of the literature of a particular period, problem, or aspect of European history. May be repeated for credit with permission of department chairman.

452. Research in American History (3)
An intensive research seminar on a phase of American history. May be repeated for credit with permission of department chairman.

453. Research in English History (3)
An intensive research seminar on a phase of English history. May be repeated for credit with permission of department chairman.

454. Research in Latin American History (3)
An intensive research seminar on a phase of Latin American history. May be repeated for credit with permission of department chairman.

457. Research in European History (3)
An intensive research seminar on a phase of European history. May be repeated for credit with permission of department chairman.

HUMANITIES PERSPECTIVES ON TECHNOLOGY

The Humanities Perspectives on Technology (HPT) Program is a broadly based effort on the part of Lehigh faculty, especially from the College of Arts and Science, to foster undergraduate courses concerned with the interrelationship between technological advance and the quality of human life. Students from each of the three undergraduate colleges are actively sought as participants.

The program offers a minor in Technology and Human Values which is open to students in the College of Arts and Science and the College of Business and Economics. Students in the College of Engineering and Physical Sciences may elect to take HPT courses under their General Studies program. The minor ordinarily consists of eighteen hours, with two required courses and four electives. The student must take HPT 97 and a course in the History of technology (such as History 5, 6 or 8). The elective courses, spread over the various fields in the humanities and social sciences, are chosen with the advice of the director of the program in consultation with the students.

Courses

HPT 97. Technology and Human Values (3) fall-spring
The study of the impact of technology on society as seen from such humanistic disciplines as literature, art, philosophy, history, folklore, and film.

HPT 98. Independent Study (1-3) fall-spring

Other HPT courses. The following special courses are offered by various departments. Descriptions may be found under the entry for the individual department.

Biol 1	Biology and Society
Eco 311	Environmental Economics
Engl 89	Science Fiction
Engl/ Phil 150	Media and Values
Engl 383	Experimental Literature
Govt 357	Technology Assessment
Hist 5	The Machine in America to 1900
Hist 6	The Machine in Modern America
Hist 8	Medicine and Society
Hist 340	History of Medicine
Hist 341	The Development of Federal Science Policy
Hist 342	The American Engineer
IR 41	Science, Technology, and International Relations
IS 11 or 12	Computer Programming—Applications for the Humanities and Social Sciences
IS 202	Computers and Society
Journ 123	Basic Science Writing
Journ 124	Politics of Science
Journ 125	Environment, The Public, and the Mass Media
Journ 126	Writing about the Environment
Journ 313	Advanced Topics in Science Writing
Latin 204	The Ancient City
Music 153	Electronic Music
Phil 42	The Scientific Process
Phil 75/ Psych 75	Behavior Control and Human Values
Phil 100	Philosophy of Contemporary Civilization
Phil 116	Medical Ethics
Phil 261	Introduction to the Philosophy of Science
Psych 201	Industrial Psychology
RS 202	Technology—Science—Theology
SR 131	Science, Technology, and Society
SR 151	Utopias and Alternative Communities
SR 311	Social Ecology

The program is constantly developing new courses. Bulletins announcing and describing them are published regularly. For further information, consult the HPT director.

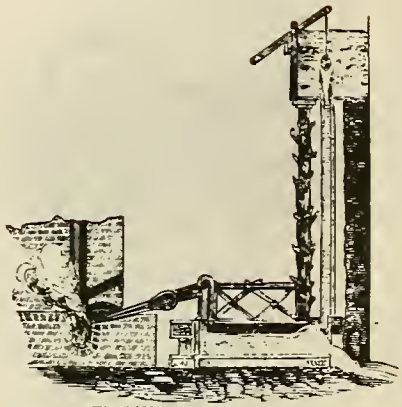

Fig. 1405.— CATALAN FORGE.

INDUSTRIAL ENGINEERING

Professors. George E. Kane, M.S., chairman; Arthur F. Gould, M.S.; Sutton Monro, B.S.; Wallace J. Richardson, M.S.; Gary E. Whitehouse, Ph.D.

Associate professors. John W. Adams, Ph.D.; Mikell P. Groover, Ph.D.; Ben L. Wechsler, Ph.D.; Emory W. Zimmers, Jr., Ph.D.

Assistant professors. Larry E. Long, Ph.D.; Louis J. Plebani, Ph.D.

Instructor. John W. Nazemetz, B.S.

Course of study

The curriculum is designed with the principal aim of industrial engineering in view, which is the design, improvement, and installation of integrated systems of people, materials, and equipment for operations by the application of the principles of the mathematical, physical, and behavioral sciences.

Throughout the program there is an integrated series or sequence in the major field which includes not only basic and fundamental courses but specialized courses as well, in the fields of production planning and control, quality control, computer-aided manufacturing, production engineering, information systems, and operations research. These specialized courses reflect the impact of recent developments in operations research, information processing, and automation.

Career Opportunities

There is a growing tendency on the part of industries to select young people from their engineering departments for managerial positions. Because of this the industrial engineering courses are oriented to the principles of scientific management to enable the industrial engineering graduate to accept and succeed in these opportunities.

It is the aim of the industrial engineering program to develop the potential manager for either the manufacturing or service industry as well as the government agency, a graduate well grounded in the fundamentals of science, trained in the principles of engineering analysis and design, and thus adequately prepared to practice the profession of industrial engineering.

Physical facilities

The manufacturing processes laboratory of this department affords an opportunity to students for gaining skills in experimental design, collection of data, instrumentation calibration and use as a complement to other educational opportunities. The computer-aided manufacturing portion of this laboratory represents the most recent addition to this facility and presents the student with the very special occasion of the coupling of mini-computers and manufacturing processes for purposes of data collection, analysis and control.

Considerable use is made of the Computing Center facilities in all levels of course work.

Special programs and opportunities

The electives within the industrial engineering curriculum.
The industrial engineering curriculum offers a very extensive program of electives that permits the student to shape a program of study that reflects personal interests. The over-all program of electives is comprised of:

21 credit hours of engineering science electives
15 credit hours of advanced industrial engineering electives
15 credit hours of General Study electives
12 credit hours of free electives

The use of electives to emphasize an area within industrial engineering.
Lehigh's industrial engineering department emphasizes four areas: information systems, manufacturing engineering, operations research and operations management. Students may choose their electives to emphasize one of these areas. Examples of using the elective program for this purpose are:

information systems emphasis

suggested course work

engineering science — 21 hours

EE 20, 105, 141	Circuits & Circuit Theory
Mech 103	Principles of Mechanics
CE 121	Mechanics of Fluids
Met 63	Materials Science

IE electives — 15 hours

IE 307	Information Systems Analysis
IE 309	Information Systems Development
IE 310	File Structure and Processing
IE 311	Decision Processes
IE 342	Computer-Aided Manufacturing

General Studies — 15 hours

Speech 30	Fundamentals of Speech
Journ 21	Creative Writing
Journ 311 or Engl 142	Science Writing, or Technical Writing
SR 131	Science, Technology and Society
Psych 1	Introduction to Psychology

free electives — 12 hours

Math 105, 362	Computer Programming and Computer Languages
Mgt 270 or IE 334	Organizational Theory or Organizational Planning and Control
IE 325 or Acct 311	Production Control, or Accounting Information Systems

manufacturing engineering emphasis

suggested course work

engineering science — 21 hours

Mech 1, 11, 102	Mechanics of Solids
Met 63, 315	Materials Science
CE 121	Mechanics of Fluids
EE 160 or ME 104	Electrical Science, or Thermodynamics

IE electives — 15 hours

IE 325	Production Control
IE 335	Sampling and Quality Control
IE 340	Production Engineering
IE 342	Computer-Aided Manufacturing
IE 344	Metal Cutting Theory

General Studies — 15 hours

SR 131	Science, Technology and Society
Psych 1	Introduction to Psychology
Eco 105	Microeconomic Analysis
Eco 335	Labor Economics
Speech 30	Fundamentals of Speech

free electives — 12 hours

Engl 142	Technical Writing
IE 311	Decision Processes
IE 334	Organizational Planning and Control
IE 336	Analysis of Experimental Data

operations research emphasis

suggested course work

engineering science — 21 hours

EE 160, 317, 342	Electrical Science
CE 121	Mechanics of Fluids
Mech 1, 102	Mechanics of Solids
ME 104	Thermodynamics

IE electives — 15 hours

IE 311	Decision Processes
IE 315	Advanced Operations Research Techniques
IE 325	Production Control
IE 335	Sampling and Quality Control
IE 336	Analysis of Experimental Data

General Studies — 15 hours

Phil 14	Foundations of Logic
Phil 314	Logical Theory
SR 131	Science, Technology and Society
Speech 30	Fundamentals of Speech
Eco 105	Microeconomic Analysis

free electives — 12 hours

Engl 142	Technical Writing
Math 309	Probability Theory
IE 307	Information Systems
IE 309	Information Systems Development

operations management emphasis

suggested course work

engineering science — 21 hours

Mech 1, 11, 102	Mechanics of Solids
Met 63, 315	Materials Science
EE 160	Electrical Science
CE 121 or ME 104	Mechanics of Fluids, or Thermodynamics

IE electives — 15 hours

IE 309	Information Systems Development
IE 311	Decision Processes
IE 325	Production Control
IE 342	Computer-Aided Manufacturing
IE 334 or IE 335	Organizational Planning and Control, or Sampling and Quality Control

General Studies — 15 hours

Psy 1	Introduction to Psychology
Eco 105	Microeconomic Analysis
Speech 30	Fundamentals of Speech
Eco 229	Money and Banking
Eco 335	Labor Economics

free electives — 12 hours

Law 201	Business Law
Fin 225	Business Finance
Mkt 211	Contemporary Marketing
IE 340	Production Engineering, or
IE 310	File Structure and Processing

The use of electives to pursue a technical minor.

Students may elect to use their electives to obtain a technical minor. A technical minor requires a minimum of fifteen credit hours.

The engineering minors available to IE majors include molecular biophysics, chemical processing and computer engineering. The computer engineering minor could be accomplished in the following manner:

EE 11	Principles of Computing Techniques (free elective)
EE 141	Switching Theory and Logic Design (engineering science elective)
EE 315	Principles of Computer Software (free elective)
EE 311	Compiler Design (free elective)
EE 317	Analytical Methods for Information Sciences (engineering science elective)

The use of electives to pursue a non-technical minor.

Students may choose to pursue non-technical minors ranging from classics to economics. A non-technical minor requires a minimum of fifteen credit hours. A possible minor in economics might be accomplished as follows:

Eco 219	Macroeconomic Analysis (General Studies elective)
Eco 303	Economic Development (General Studies elective)
Eco 310	Economic Evolution (General Studies elective)
Eco 311	Environmental Economics (General Studies elective)
Eco 335	Labor Economics (free elective)

The use of electives to fulfill background requirements leading to the MBA.

The College of Business and Economics offers a Masters of Business Administration Degree. The program as presented would take two years (the first year being a set of prerequisites). Based on an agreement with the College of Business and Economics, it is possible to realize all first year prerequisites to MBA as part of the BS in IE program. Thus, it is possible to obtain the MBA in one year after completing the BS in IE given that requirements for admission to the Graduate School are met.

The BS in IE would meet the MBA requirements as follows:

Acctg 108, Fundamentals of Accounting, is required.
IE 18, Data Processing Fundamentals, is substituted for Acctg. 111, Computers in Business.
IE 205, Engineering Statistics, is substituted for Eco 45, Statistical Method.
IE 206, Operations Research Techniques, is substituted for Mgt 269, Management of Operations in Organizations.
Fin 225, Business Finance, is taken as a free elective.
Mkt 211, Contemporary Marketing, is taken as a free elective.
Law 201, Business Law is taken as a free elective.
Eco 229, Money and Banking, is taken as a General Study elective.
Eco 105, Microeconomic Analysis, is taken as a General Study elective.
IE 334, Organization Planning and Control is substituted for
Mgt 270, Conceptual Foundations of Organizational Theory and Behavior.

The use of electives to emphasize another engineering discipline.

By careful use of the electives, a student can select many of the basic courses in another branch of engineering. This type of preparation would be excellent for the student interested in an operations management career in an industry emphasizing a particular branch of engineering.

Consider courses that might be selected by a student interested in emphasizing mechanical engineering:

engineering science electives

Mech 1	Statics
ME 104	Thermodynamics 1
Mech 11	Mechanics of Materials
Met 63	Engineering Materials
Mech 102	Dynamics
ME 231	Fluid Mechanics

free electives

ME 101-102	Mechanical Engineering Design
ME 312	Synthesis of Mechanisms
ME 321	Introduction to Heat Transfer
ME 340	Advanced Mechanical Engineering Design

Major requirements

freshmen year (see page 40)

sophomore year, first semester (15 credit hours)

Math 23	Analytic Geometry and Calculus III (4)
IE 5	Industrial Engineering Models (3)
Phys 21, 22	Introductory Physics II and Lab (5)
	engineering science elective (3)

sophomore year, second semester (16 credits)

IE 110	Engineering Probability (3)
IE 18	Data Processing Fundamentals (3)
	engineering science electives (6)
Eco 1	Economics (4)

junior year, first semester (16-19 credit hours)

IE 101	Fundamentals of Manufacturing Engineering (4)
IE 205	Engineering Statistics (3)
Math 205	Linear Methods (3)
	engineering science elective (3)
	General Studies elective (3)
	elective (0-3)*

junior year, second semester (16-19 credits)

IE 102	Work Systems (3)
IE 206	Operations Research Techniques (4)
	Engineering Science Electives (6)
	General Studies elective (3)
	elective (0-3)*

summer

IE 100	Industrial Employment

senior year, first semester (15-18 credits)

Acctg 108	Fundamentals of Accounting (3)
IE	Electives (6)
	engineering science elective (3)
	General Studies elective (3)
	elective (0-3)*

senior year, second semester (15-18 credits)

IE 154	Senior Project (3)
IE	electives (9)
	General Studies elective (3)
	elective (0-3)*

For engineering science electives see approved list in the industrial engineering office.
*please refer to description of normal program. page 40.

Course descriptions

Undergraduate courses

5. Industrial Engineering Models (3) fall
Deterministic models in the planning activities associated with industrial engineering, including engineering economy, flow chart construction and analysis, and fundamentals of production control. Laboratory.

18. Data Processing Fundamentals (3) spring
Study of data representation and recording media. The functions of input/output devices, storage devices and the central processing unit in the conversion of data to information. Fundamentals of system analysis and design. Programming projects using FORTRAN IV and COBOL. Laboratory. Prerequisite: Engr 1 or equivalent.

100. Industrial Employment (0)
Usually following the junior year, students in the industrial engineering curriculum are required to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Prerequisite: sophomore standing.

101. Fundamentals of Manufacturing Engineering (4) fall
Study of metal processing theory with emphasis on machining, numerical control, special processing techniques, work-holder design, laboratory experiments.

102. Work Systems (3) spring
Techniques in methods improvement and work measurement. The applications of these techniques to the analysis, design and control of man-machine work systems. Time study, predetermined time systems, work sampling and standard data. Plant layout project. Laboratory. Prerequisites: IE 101, IE 205.

105. Thesis (3-6)
Candidates for the bachelors degree in industrial engineering may, with the approval of the

department staff, undertake a thesis as a portion of the work of the senior year. Prerequisite: senior standing.

110. Engineering Probability (3) spring
Introduction to the use of probability to solve engineering problems. Sampling distributions for estimation and elementary stochastic processes for modelling. Laboratory. Prerequisite: Math 23 previously or concurrently.

154. Senior Project (3) fall-spring
Special study of a problem involving project work in a local industrial plant or service institution. Project work includes consideration of the behavioral sciences. Laboratory. Prerequisite: senior standing in industrial engineering.

168. Production Analysis (3) fall-spring
A course for the engineering student not majoring in industrial engineering. Engineering economy; application of quantitative methods to facilities analysis and planning, operations planning and control, work measurement and scheduling, and operating systems analysis. Prerequisites: Math 22 or 42; Eco 1.

For advanced undergraduates and graduates

205. Engineering Statistics (3) fall
Applications of point and confidence interval estimation and hypothesis testing to the fitting of frequency and regression models, to acceptance and control sampling and to elementary design of experiments. Prerequisite: IE 110 or Math 231, or equivalent.

206. Operations Research Techniques (4) spring
The development and use of the elementary techniques of operations research. Topics include linear programming, queueing theory, probabilistic inventory models and simulation. Prerequisites: IE 110 or Math 231, Math 205.

212.Elementary Design of Experiments (3)
An introduction to the structure of experiments, the analysis of experimental data, and their interrelation. Measurement error, randomization, pairs and blocks; regression and analysis of variance. Prerequisite: graduate standing or consent of department chairman.

300. Apprentice Teaching in IE (1-3)

307. Information Systems Analysis (3) spring
Study of techniques used, and their application, in the design of information systems. Graphical, matrix, and investigative techniques used in system definition; information network models; simplification methods, feedback concepts; simulation. Prerequisite: IE 18 or Acctg. 111, IE 206 or Mgt 302 or equivalent.

309. Information Systems Development (3) fall
Study of information systems development to include design, implementation, evaluation and management. Introduction to data structure concepts, their use in the production of information for an organization and their effects on organizational relationships. Conduct a feasibility study for an information system. Prerequisite: IE 18 or Acctg 111 or equivalent.

310. File Structure and Processing (3) spring
Study of data structures and file organization for effective processing by computer to include storage management and generation, update, sorting, searching, and query techniques using COBOL. Introduction to data base design and data base management systems. Prerequisite: IE 309 or Acctg 311 or equivalent.

311. Decision Processes (3) spring
Application of the techniques of operations research for decision making. Topics include decisions under certainty, decisions under risk, decisions under uncertainty, value of sampling information, decision trees and game theory. Prerequisite: IE 206 or Mgt 302.

315. Advanced Operations Research Techniques (3) fall
A survey of advanced topics in operations research. Topics include advanced linear programming, dynamic programming, integer programming, Markov chains and network techniques. Prerequisite: IE 206 or consent of department chairman.

321. Experimental Industrial Engineering (1-3)
Experimental projects in selected fields of industrial engineering, approved by the instructor. A written report is required.

322. Experimental Industrial Engineering (1-3)
Continuation of IE 321.

325. Production Control (3) fall
Quantitative techniques appropriate for the analysis of production and inventory control systems. Topics include forecasting, inventory models, aggregate planning, scheduling and sequencing. Prerequisite: IE 206 or Mgt 302 or equivalent.

334. Organizational Planning and Control (3) spring.
Design of organization and procedures for managing functions of industrial engineering. Analysis and design of resources planning and control, including introduction of change in man-machine systems; manpower management and wage administration. Prerequisite: IE 102 or 168.

335. Sampling and Quality Control (3) fall
Random, stratified and optimal sampling plans, using fixed and sequentially determined sample sizes. Application to quality assurance and other analyses of operations. Stochastic methods for continuous inspection and Bayesian procedures for acceptance inspection. Prerequisite: IE 205.

336. Analysis of Experimental Data (3) spring
Use of linear and nonlinear least squares to find models which identify cause and estimate effect. Application of transformation, analysis of variance and covariance. Prerequisite: IE 205.

340. Production Engineering (3)
Develop plans of manufacturing for discrete parts. Product design analysis and engineering materials utilization. Economic analysis of process design alternatives. Introduction to mechanization and automation. Term project. Laboratory. Prerequisite: IE 101.

342. Computer-Aided Manufacturing (3)
Analysis and design of manufacturing systems using digital computers. Principal topics: computer-aided design techniques, group technology, applications of mini-computers to manufacturing systems. Introduction to adap-

Fig. 1683. — MAGNOLIA GRANDIFOLIA.

tive control, numerical control, and optimization strategies for discrete parts manufacturing. Term project. Prerequisites: IE 18, IE 101 or equivalent.

344. Metal Cutting Theory (3) spring
Intensive study of metal cutting emphasizing temperature and energy relationships and their effect on tool life, power requirements and surface finish. Economic balancing of metal cutting variables from application of theory. Lectures and laboratory experiments including designing and conducting an original experiment. Prerequisite: IE 101.

For graduates

Course of study.

Programs leading to the master of science and doctor of philosophy degrees are offered by the department of industrial engineering in the following fields: manufacturing engineering, information systems, and operations research.

There is a program of study available leading to the master of engineering degree in industrial engineering.

Major requirements

Master of science in industrial engineering: The minimum program for the master of science degree consists of twenty-four hours of approved course work and completion of a satisfactory thesis.

An M.S. program is selected to meet the interests and needs of the student, and courses in other departments for which the student has the prerequisites may be integrated into the major field. Subject to proper approval, nine hours of 400-level courses from outside the department may be included among the courses required in the major field. As part of a purposeful major program, collateral courses may be taken in other branches of engineering, mathematics, economics, psychology, and information science.

Master of engineering in industrial engineering: This program of study is for those students whose interests are toward design rather than research. This program will provide opportunity to gain breadth of field by required course work in all areas of study within the department. In addition a design project is carried out under the supervision of the faculty that further emphasizes breadth of field.

Doctor of philosophy in industrial engineering: The Ph.D. program is organized to meet the individual goals and interests of industrial engineering students who plan to engage in teaching, consulting, or research activities in industrial, governmental, or educational environments.

The objective of the program is to educate these students to perform their respective activities at a high level of proficiency. To this end, each doctoral student is required to: 1. demonstrate competency in several broad fields of industrial engineering related to a personal area of interest; 2. prepare, through formal course work and independent study, for examination in the student's particular area of specialization by members of the graduate faculty; and 3. present a dissertation related to the field of specialization which embodies the results of original research, shows evidence of high scholarship, and constitutes a contribution to knowledge.

Fig. 55. — AGOUTI.

Further information about the Ph.D. program is contained in the Graduate School section of this publication and in a brochure prepared by the department.

Areas of graduate study

The areas of graduate study and research which are emphasized in the department of industrial engineering are:

Operations Research. Emphasis is placed on both the development and applications of operations research techniques. The program is strongly analytical in approach and content. Emphasis is placed on understanding practical problems so that suitable mathematical models can be selected or developed. Such models may be drawn from such areas as inventory theory, queueing theory, simulation, decision theory, dynamic programming, and mathematical programming theory. The operations research student is motivated by a program which emphasizes the mathematical, probabilistic, statistical, and computer sciences.

Information systems. The field of information systems embodies management information for decision-making and planning, operational systems to control man-machine activity, and methods for system analysis and design. The role of the human is stressed in data gathering, information processing and interaction with system output.

Study and research work relate to performance of computer-based systems, including evaluation criteria and cost effectiveness. Project management, simulation, data management and economic analysis principles and techniques are employed as basic tools in research activities.

Manufacturing engineering. Graduate study in manufacturing engineering involves course work and research opportunities in specific areas related to manufacturing.

The department is currently interested in such areas as metal processing theory, automation and numerical control, manufacturing systems and management, and work systems. Additional related courses are offered in other departments in the College of Engineering and Physical Sciences.

The manufacturing processes laboratory is available for the study of metal cutting processes and the lab is coupled with course offerings in the same area.

The department offers courses during the late afternoon for the convenience of students who are employed in local industry and are taking graduate work on a part-time basis. There is no evening program, however.

Course descriptions

405. Special Topics in Industrial Engineering (3)
An intensive study of some field of industrial engineering.

408. (Acctg 408) Management Information Systems (3)
Integrated and total systems concepts for organizational data bases and information systems as applied to planning, development and implementation of computer-based management information systems. Emphasis placed on the interaction of information systems with management planning and control. Prerequisite: an advanced course in information systems and a knowledge of programming.

410. Design of Experiments (3)
Fixed, mixed, and random models, fractional factorials, unequal cell frequencies. Sequential design for estimation and optimization. Prerequisite: a course in statistical inference.

415. Manufacturing Management (3)
Analysis of the factors entering into the development of manufacturing management philosophy; decision-making process in areas of organization, planning, operation, and control of manufacturing. Influence of the social, technical, and economic environment upon manufacturing management decisions.

416. Dynamic Programming (3)
The principle of optimality; one-dimensional processes, multi-dimensional processes, LaGrange multiplier technique. Markovian decision processes; applications.

417. Advanced Mathematical Programming (3)
Theory and applications of the extensions of linear programming. Kuhn-Tucker conditions, gradient methods of optimization, simplex based methods of nonlinear programming, integer programming, branch and bound, zero-one discrete programming and stochastic programming. Prerequisite: a course in linear programming.

418. Simulation (3)
Application of discrete and continuous simulation techniques to model industrial systems; random number generation and testing; design of simulation experiments; simulation languages. Prerequisite: knowledge of FORTRAN and a course in probability theory.

428. Advanced Work Systems (3)
A critical evaluation of methods improvement and work measurement techniques. Emphasis on design of work systems, productivity improvement, and reporting systems to control work. Work sampling, construction of standard data, mathematical models of work systems.

430. (Mgt 430) Management Science Project (3)
spring
An analysis of a management problem and design of its solution incorporating management science techniques. An individual written report is required. Recommended to be taken in the last semester of the program.

431. Operations Research Seminar (3)
Extensive study of selected topics in techniques and models of operations research.

433. Manufacturing Engineering Seminar (3)
Extensive study of selected topics in the research and development of manufacturing engineering techniques.

435. Mathematical Methods in Operations Research (3)
The fitting of data using splines and Polynomials. The use of differential equations, difference equations, Laplace transforms, generating functions and matrices in the solution of problems arising in scheduling, inventories, maintenance, queueing and replacement. Prerequisites: calculus, linear algebra, knowledge of FORTRAN or equivalent.

438. Real Time Information (3)
Planning and management of real time, on-line information systems; effect of data banks, multiprocessing, time-sharing, and supervisory routines; data gathering and display techniques for interactive systems; data communications. Prerequisite: IE 310 or consent of department chairman.

439. Applications of Stochastic Processes (3)
Introduction to stochastic processes, application in queueing theory and inventory theory. Prerequisites: a course in probability theory and IE 435.

441. Network Modeling Techniques (3)
A critical study of various network modeling techniques. Topics include: PERT, CPM, network flows, decision trees, flowgraph analysis and GERT. Emphasis will be placed on the modeling and analysis of systems using these techniques.

444. Design of Cutting Tools (3)
A study of design parameters including tool materials, tool geometry and cutting conditions for material removal operations. Emphasis will be placed on the influence of tool selection variables, on economy of operation and conformance to product requirements.

445. Production Automation (3)
Concepts and principles of automated production lines; analysis of transfer lines; partial automation; mechanized assembly; line balancing; product and process design considerations.

447. Manufacturing Systems (3)
Numerical control in manufacturing; manual and computer-assisted part programming; computer process control including monitoring and direct digital control of manufacturing operations; adaptive control and other techniques of process optimization.

450. Manufacturing Problems (3)
Discussion and solution of manufacturing problems involving several subfunctions, with emphasis on problem identification and definition; selection of techniques of analysis; procedures for evaluation of proposed solutions.

460. Engineering Project (1-6)
An intensive study of an area of industrial engineering with emphasis upon design and application. A written report is required.

461. Readings (1-3)
Intensive study of some area of industrial engineering which is not covered in general courses.

490. Research Methods Seminar (3)
Research methods in industrial engineering; discussion and critical analysis of current industrial engineering research; practice in preparation of research proposals.

INTERNATIONAL RELATIONS

Professors. Oles M. Smolansky, Ph.D., chairman; Henderson B. Braddick, Ph.D.; Carey B. Joynt, Ph.D., Rathbone professor.

Associate professor. Zdenek J. Slouka, Ph.D.

Assistant professors. Michael R. Hodges, Ph.D.; Raymond F. Wylie, Ph.D.

The field of international relations poses an unprecedented challenge to student and teacher alike and provides a stimulating focus of interest for undergraduate education.

It demands full recognition and understanding of the vast forces which are shaping the world—wars, nationalism, political ideologies, and modern technology. The leadership and responsibilities of the United States in the world arena have created a need for broadly educated men and women who possess a clear appreciation of the factors which influence the policies of nations.

Students approach the study of state behavior through three major analytical perspectives: intergovernmental relations (including courses in the theory and techniques of diplomacy, the history of modern international relations, and special seminars in international law, international institutions, and world politics), transnational relations (especially economic, ideological, and technological interactions), and area studies (European, Soviet, Middle Eastern, and Asian affairs).

The ultimate objective is to shape and develop well-informed and independent observers and participants in the field of international affairs. The flexibility of the program permits added study in history, government, economics, and other social sciences.

A special program is available in World Order Studies, a program which takes special account of the problems of world peace, transnational relations, and the impact of science and technology on international relations. Students taking this option should select twelve semester hours, in addition to their required major courses, from the following list: IR 41, 47, 101, and 301-305.

A Minor Program (5 courses/15 credit hours) is available for those students who wish to acquire a more systematic knowledge of world affairs in addition to their major area of study. The program permits students to survey the general field of international relations, yet acquire a deeper understanding of those aspects of the discipline directly related to their major programs.

The broad knowledge and understanding acquired can be utilized in careers in teaching, the Foreign Service of the United States and other government agencies, international business, and the legal profession.

Required preliminary courses

IR 1, 2	World Politics (6)

Required major courses

IR 341, 342	International Relations (6)
IR 353	International Institutions (3)
IR 354	The Atlantic Community (3)
IR 361, 362	International Law (6)

and twelve semester hours to be selected, with the approval of the department chairman, from international relations, history, and government.

Undergraduate courses

1. World Politics (3) P
Interdisciplinary approach to understanding the impact of political, economic, and social factors on international relations. Emphasis on current international developments. Messrs. Hodges and Wylie.

2. World Politics (3) P
Introduction to the foreign policies of the major powers — United States, Soviet Union, China, Britain, France, Germany, Japan, and India— and of regional groupings in Europe, Asia, Middle East, Africa, and Latin America. Emphasis on current international developments. Messrs. Hodges and Wylie.

11. European International Relations, 1815-1919 (3) P
Politics of the Great Powers; clashes of interests and international crises; development of alliances and other associations of states; wars and peace settlements; unification of Germany and Italy; influence of nationalism, the industrial revolution, and social ideologies on international relations; World War I and the peace treaties. Mr. Braddick.

12. European International Relations Since 1919 (3) P
Political and strategic structure of Europe in the 1920s; rise of Nazi Germany; politics of international crises, 1935-39; World War II and the new distribution of power in Europe; development of the Cold War; European functional integration; contemporary European international problems; European relations with the United States. Mr. Braddick.

21. Modern East Asia (3) P
International relations of East Asia to 1945, with emphasis on 20th-century: Western impact and Eastern response; origins and course of Chinese revolution; rise and fall of Japanese empire; emergence of United States and Soviet Union as Asian powers. Mr. Wylie.

22. Contemporary East Asia (3) P
International politics of East Asia since 1945, with emphasis on recent developments: origins of Cold War in East Asia; rise of China as world power; emergence of Japan as industrial giant; policies of United States and Soviet Union in Asia. Mr. Wylie.

31. Middle East in World Affairs to 1945 (3) P
Political, economic and social forces behind the rise of modern states in the Middle East; area's role in international politics from Napoleon's invasion of Egypt to the end of World War II. Mr. Smolansky.

32. Middle East in World Affairs Since 1945 (3) P
Rise of Turkish, Iranian and Arab nationalism; creation of Israel; decline of British and French power; growth of U.S. and Soviet influence; Middle East and the world's major oil producer. Mr. Smolansky.

41. Science, Technology and International Relations (3) P
International impact of selected technologies and scientific fields: marine science and engineering, weather modification, genetic engineering, environmental controls, communication and remote sensing satellites. Mr. Slouka.

47. Transnational Relations and World Politcs (3) P
Survey of nongovernmental institutions and processes cutting across national boundaries. Prerequisite: IR 1 or 2 or consent of department chairman. Mr. Slouka.

51. American Foreign Policy Since 1945 (3) P
American foreign policy from Cold War to detente. Examination of Nixon-Kissinger policy to show how changing international conditions affect the premises, concepts and objectives of U.S. policy. Mr. Joynt.

80. Politics of Oil (3) P
Rise of large international oil companies since 1920 and their relations with the governments of producing and consuming countries, culminating in the formation of OPEC and the emergence of the "energy crisis." Mr. Hodges.

101. Politics of European Integration (3) U
Integration process in contemporary West Europe; European Communities as examples of peaceful community-building at supranational level. Institutional development of European Communities and the political, economic, and social dynamics of regional integration in West Europe. Mr. Hodges.

133. Diplomacy of Russia to 1945 (3) U
Expansion of the Russian Empire; Russian foreign policy under the tsarist and communist governments; interaction between domestic and foreign affairs; Soviet efforts to survive in a "hostile capitalist environment." Mr. Smolansky.

134. Diplomacy of Russia Since 1945 (3) U
Consolidation of gains made during and after World War II; origins of Cold War; frictions within the communist bloc (Eastern Europe and China); nuclear arms race and striving for detente. Mr. Smolansky.

181. Workshop in Research Methods (1) U
Basic methods in international relations research, with emphasis in technical methods of research design, outlining and abstracting, documentation and presentation. Designed for IR majors in their junior year. Consent of department chairman required.

214. (RS 214) International Affairs and Political Theology (3) U
Theological assessments of the nation-state, the role of power in international affairs, national sovereignty and internationalism, war, pacificism, and alternative methods of conflict-resolution. Mr. Eckardt.

Advanced undergraduate courses

300. Apprentice Teaching in International Relations (3) U

301. (Govt 301) International Policy-Making (3) U
Policy-making processes in the contemporary world; impact of assumptions and projections of future social and technological change on international decisions. Prerequisite: IR 1 or 2 or consent of department chairman. Mr. Slouka.

302. War and World Politics (3) U
The role of war in the modern world; changing functions of war; why nations go to war; great power wars, limited wars, civil wars, and intervention; the examples of Hitler's Germany, Japan, Korea, Vietnam, and the Arab-Israeli conflicts. Mr. Joynt.

303. International Peace Studies (3) U
The problem of achieving a peaceful world order; the dynamics of conflict; the role of force, law, and morals. Evaluation of the proposed solutions to violent change. The nuclear era and the challenges to order posed by scarce resources and growing interdependence. Mr. Joynt.

304. Multinational Corporations As International Actors (3) U
Economic, political and social role of multinational corporations in the international system; emphasis on relations between multinational corporations and national governments. Prerequisite: IR 1 or 2. Mr. Hodges.

305. (Govt 305) Dynamics of Regional Integration (3) U
Theories of regional integration; supranational community-building in West Europe, North Atlantic area, and developing countries in Latin America, Asia and Africa. Mr. Hodges.

308. (Govt 308) Ideologies in World Affairs (3) U
Role of ideologies in world affairs, emphasizing contemporary issues: nationalism and imperialism; European fascism and Japanese militarism; classical and Soviet Marxism-Leninism; thought of Mao Tse-tung; Third World ideologies and revolutionary movements; current ideological trends. Mr. Wylie.

311. World Affairs, 1919-1945 (3) U
International relations between the world wars; structure of the state systems in 1919-22; ideals and realities of the League of Nations; challenge of Nazi Germany, Japan, Fascist Italy and Soviet Russia; appeasement; crises of the 1930s; and World War II. Mr. Braddick.

312. World Affairs Since 1945 (3) U
International relations after World War II; its impact on the state system; Cold War and development of bipolar international politics; United Nations as an instrument for international order and security; decline of the colonial system and emergence of new states; development of Communist China and Western Europe as new power centers; and contemporary problems in international relations. Mr. Braddick.

318. (Govt 318) Communist Political Systems (3)
Examination of communist political systems outside the USSR and the operations of nonruling communist parties.

321. China in World Affairs (3) U
Role of China in world affairs, emphasizing triangular relationship between China, United States and Soviet Union. Other topics include: Maoist ideology and domestic politics; making of foreign policy; relations with Japan and Europe; policies toward the Third World; current and future problems. Mr. Wylie.

322. (Govt 322) Politics of Developing Nations (3)
Theories of political development in non-Western areas: modernization and nation building. Field studies and methods; contributions of related disciplines such as sociology and psychology.

324. (Govt 324) Political Systems in Transition (3) spring
The responses of selected non-communist states to contemporary problems. May be repeated for credit with consent of the department chairman. Mr. Yates.

332. Contemporary Soviet Policy in the Middle East (3) U
Underlying causes, interests and motivations of Soviet policy in the Middle East during the post-Stalin era; effect on activities of Khrushchev and Brezhnev of superpower relations, regional politics and Russia's traditional interests in region. Mr. Smolansky.

334. Soviet Union in World Affairs (3) U
Objectives, strategy and tactics of Soviet diplomacy; Russia's status as a superpower. Prerequisite: IR 134 or consent of department chairman. Mr. Smolansky.

341. International Relations (3) U
Contemporary theories and basic concepts of world politics; application to historic and current issues of international relations. Mr. Joynt.

342. International Relations (3) U
Role of force in international politics: deterrence, limited war, problems of arms control and disarmament; crisis diplomacy. Mr. Joynt.

353. International Institutions (3) U
Theory and functioning of the League of Nations and the United Nations; problems of peace and security; regional and functional organizations. Mr. Braddick.

354. Atlantic Community (3) U
Political, cultural and strategic influences affecting relationship between Western Europe, United States, and Canada; NATO; strains in the Community and prospects. Mr. Braddick.

361. International Law (3) U
Foundation and structure of international law; sources of international legal rights and obligations; rules governing coexistence, interaction, and conflict of states; international law-making and adjudication. Mr. Slouka.

362. International Law (3) U
Function of international law in world politics; rise and demise of international legal norms: social, political, economic, cultural and technical forces shaping world legal order. Prerequisite: IR 361. Mr. Slouka.

371. Readings in International Relations (3) U
Directed course of reading intended for students with special competence or interest in fields of international relations not fully covered by regular course offerings. May be repeated for credit.

372. Readings in International Relations (3) U
Continuation of IR 371. May be repeated for credit.

Fig. 312.—COLLAR AND BADGE OF THE BATH.

381. Special Topics (3) U
Intensive study of some aspects of international politics not covered in another course.

382. Special Topics (3) U
Continuation of IR 381.

391. Teaching of International Relations (3) U
Fundamental principles and problems of international relations, including current applications. Open only to present and prospective junior and senior high school teachers. Mr. Slouka.

MANAGEMENT AND FINANCE

Professors. Carl R. Beidleman, Ph. D., Dubois professor of finance and chairman; Brian G. Brockway, LL.M., dean of the College of Business and Economics; James B. Hobbs, D.B.A.; Eli Schwartz, Ph.D.; Max D. Snider, M.B.A., associate dean of the College of Business and Economics.

Associate professors. John W. Bonge, Ph.D.; James E. Hansz, Ph.D.; Leon E. Krouse, Ph.D.; Benjamin Litt, Ph.D.; R. Charles Moyer, Ph.D.

Assistant professors. Stephen G. Buell, Ph.D.; James A. Greenleaf, Ph.D.; Raymond L. Horton, D.B.A.; Bruce M. Smackey, Ph.D.; John E. Stevens, Ph.D.; Seymour Traub, J.D.

Adjunct professors. Harry A. Dower, LL.B.; Edward H. McGee, LL.B.

Instructors. R. Kraft Bell, M.B.A. John L. Tucker, M.B.A.

Finance

major in the College of Business and Economics

required: fifteen credits beyond the core listed on page 37, from the following:

Fin 323	Investments (3)
Fin 324	Security Analysis (3)
Fin 326	Problems in Financial Management (3)
Fin 330	Financial Flows and Markets (3)
Fin 331	Bank Management (3)
Fin (Eco) 332	Monetary-Fiscal Policy (3)
Fin (Eco) 340	International Finance (3)
Fin (Eco) 353	Public Finance: Federal (3)
Fin (Eco) 354	Public Finance: State and Local (3)
Fin 371	Directed Readings (1-3)
Fin 372	Special Topics (1-3)

For advanced undergraduates and graduates

225. Business Finance (3) fall-spring
An introductory course in corporation finance which stresses the management approach as it applies to asset management and capital structure. Emphasis is placed on financial policies regarding the acquisition of funds and

Fig. 219.— RUINS OF THE ACROPOLIS OF ASSUS.

their allocation to competing assets within the firm. Problems are used to illustrate the principles involved. Prerequisites: Eco 45, Eco 105, Math 41 and 44, Acctg 51.

300. Apprentice Teaching in Finance (1-3) fall-spring

323. Investments (3) spring
An introduction to the investment process. The nature of risk and the form of returns to financial assets are examined. Investor objectives, attitudes and constraints are considered in conjunction with the risk-return matrix as the basis for investment decisions. Problems of timing, market characteristics and portfolio management also are treated. Prerequisite: Fin 225. Mr. Krouse.

324. Security Analysis (3) fall
Examination of factors which influence the value of financial securities, including earnings forecasts and expectations, uncertainty, investor attitudes, required returns, and the supply and demand for securities and funds. Also considered are market factors, technical approaches, timing, screening, and portfolio implications. Prerequisite: Fin 225, Acctg 111, Eco 119, Eco 229. Mr. Beidleman.

326. Problems in Financial Management (3) spring
An extension of the introductory business finance course where major topic areas such as captial budgeting, working capital management, leasing, mergers, etc., are examined in depth. Cases and more complex problems are used to illustrate the concepts covered and their application to real world situations. Prerequisite: Fin 225. Messrs. Schwartz and Tucker.

330. Financial Flows and Markets (3) alternate years
The nature and role of financial intermediaries in financial markets from a flow-of-funds perspective. Emphasis is on the interrelationships between financial and non-financial flows in the economy, and the forecasting of interest rate structures. Prerequisite: Fin 225, Acctg 111. Messrs. Krouse and Tucker.

331. Bank Management (3) alternate years
The management of bank resources and assets within the framework of economic and legal constraints. Particular attention is given to optimizing the objectives of profitability, safety and liquidity. Completion of a project in bank management is required of each student. Prerequisite: Fin 225, Eco 229. Messrs. Krouse and Tucker.

332. (Eco 332) Monetary-Fiscal Policy (3)
A course devoted to the study of monetary, credit and fiscal policies of governments and central banks with particular reference to the policies of the United States Treasury and the Federal Reserve System. Current problems receive special emphasis. Prerequiste: Eco. 219 or equivalent.

340. (Eco 340) International Finance (3)
The balance of payments and the theory of disturbances and adjustment in the international economy; international monetary policies. Mr. Jensen.

353. (Eco 353) Public Finance: Federal (3)
A course dealing with government expenditures and revenues, the economics of taxation, and government administration.

354. (Eco 354) Public Finance: State and Local (3)
The major issues regarding revenues, expenditures, debit and budgeting policy is examined in the light of fiscal principles and economic effects. Particular attention is given to current practices in Pennsylvania and contiguous states. Prerequisite: Eco 353.

371. Directed Readings (3)
A course of readings in various fields of finance, designed for the student who has a special interest in some field of finance not covered in scheduled courses. Prerequisite: consent of department chairman. May be repeated.

372. Special Topics (1-3)
Special problems and issues in finance for which no regularly scheduled coursework exists. When offered as group study, coverage varies according to interests of instructor and students. Prerequisite: consent of department chairman. May be repeated.

For graduates

401. Managerial Finance (3)
An entry level MBA course which examines the decisions involved in capital budgeting, working capital management, financing of a firm's assets, dividend policy, valuation and the cost of capital. This course is designed to meet this background requirement of a student enrolled in the MBA program. Prerequisites: Eco 405, Eco 417, Acctg 415.

415. (Eco 415) Capital and Interest Theory (3) alternate years
Examination of theories of interest and capital. The following topics are investigated: present value theory; investment valuation under certainty and risk; term structure of interest rates; the theory of savings, cost of capital, and capital formation. Prerequisite: consent of department chairman. Mr. Schwartz.

421. Financial Management (3) fall-spring
A decision-oriented course which integrates the theory and practice of business finance. Among the topics included are working capital management, capital expenditure decisions, functions of the capital markets, mergers, dividend policy, capital structure, valuation and the cost of capital. The effect of uncertainty on the problems of financial analysis is considered. Readings, case problems and decision-oriented reports are utilized to illustrate the principles involved. Prerequisite: Fin 401 or equivalent.

425. (Eco 425) Public Finance (3) spring; even-numbered years
Major issues in taxation of income consumption, and capital; principles of government debt management; budgeting and fiscal planning for economic stability and growth.

431. Advanced Investment Analysis and Portfolio Management (3) fall
This course is designed to integrate the theoretical and empirical aspects of the economic environment with the investment analysis associated with portfolio management programs of financial intermediaries and individuals. Particular emphasis is given in the course to the current impingements of the

economic environment upon portfolio management decisons. Prerequisite: Fin 421. Messrs. Greenleaf and Moyer.

442. (Eco 442) Foreign Trade Management (3) spring, odd-numbered years
Current problems of foreign operations, including channels of export in foreign markets, export and import financing, foreign investments, policies of government and international agencies as they affect foreign operations. Mr. Jensen.

444. (Eco 444) Banking and Monetary Policy (3)
Description and analysis of the U.S. monetary and banking structure. The supply and demand for funds. Financial markets. Central bank controls; monetary theory and policy. Prerequisite: a course in money and banking.

451. Quantitative Financial Models (3) alternate years
A survey of quantitative models as they relate to financial theory and applications. Finance topics include capital budgeting, portfolio selection, security evaluation, cash management, inventory policy and credit analysis. Prerequisite: Fin 421. Messrs. Greenleaf and Moyer.

471. Directed Readings (1-3)
Graduate readings in finance not covered in regularly scheduled coursework. Prerequisite: consent of department chairman. May be repeated.

472. Special Topics (1-3)
Special problems and issues in finance for which no regularly scheduled graduate coursework exists. When offered as group study, coverage varies according to interest in finance. Prerequisite: consent of department chairman. May be repeated.

Law

Undergraduate courses

11. Introduction to Law (3)
A study of the nature and function of law and the legal system; the study of legal reasoning through the use of the case method. Required first course in the legal studies minor program.

201. Business Law (3) fall-spring
The law of contracts, agency, sales under the uniform commerical code and business organizations. A case and problems approach is used to develop analytic methods and research skills involved in the examination of numerous types of commercial transactions. Prerequisite: Eco 1, Acctg 51 or Acctg 108. Mr. Traub.

202. Business Law (3) spring
The law of negotiable instruments, secured transactions, real and personal property, corporations and partnerships. A case and problem approach is used. Prerequisites: Law 201, Fin 225. Mr. Traub.

For advanced undergraduates

300. Apprentice Teaching in Law (1-3)

371. Directed Readings (1-3)
Readings in various fields of law, designed for students who have a special interest in a field of law not covered in regularly scheduled courses. Prerequisite: consent of department chairman. May be repeated.

372. Special Topics (1-3)
Special problems and issues in law for which no regularly scheduled coursework exists. When offered as group study, coverage will vary according to the interests of the instructor and students. Prerequisite: consent of department chairman. May be repeated.

For graduates

401. Legal Problems in Business (3) fall-spring
Specific legal problems involved in making business decisions. Emphasis is placed on preventive law and the tax consequences of business transactions. Prerequisite: Law 403, Fin 401. Mr. Dower.

403. Commercial Transactions and Business Organizations (3)
The study of the law of contracts, especially as it applies to the sale of goods; and the study of the law of agency, partnerships and corporations. This course is designed to meet this background requirement of a student enrolled in the MBA program. Prerequisite: Actg 415.

471. Directed Readings (1-3)
Graduate readings in law not covered in regularly scheduled courses. When offered as group study, coverage varies according to the interests of the instructor and students. Prerequisite: consent of department chairman. May be repeated.

472. Special Topics (1-3)
Special problems and issues on law for which no regularly scheduled graduate coursework exists. When offered as group study, coverage varies according to the interest of the instructor and students. Prerequisite: consent of department chairman. May be repeated.

Management

Major in the College of Business and Economics

Required: fifteen credits beyond the core listed on page 37 from the following:

required courses

Mgt 302	Quantitative Models-Conceptual (3)
Mgt 321	Organization Behavior Workshop (3)

Electives

In addition, the management major selects one of the three options shown below. An asterisk denotes courses that are strongly recommended to be taken.

quantitative (select three courses)

*Mgt 304	Quantitative Models-Applications (3)
Mkt 312	Marketing Research (3)
Acctg 324	Cost Accounting (3)
Econ 352	Advanced Statistical Methods (3)

behavioral (select three courses)

*Mgt 316	Organizational Decision Processes (3)
Mgt 331	Industrial Relations (3)
Mkt 315	Consumer Behavior (3)
SR 312	Small Groups (3)

general management (select three courses)

Mgt 311	LUMAC (3)
*Mgt 316	Organizational Decision Processes (3)
*Mkt 319	New Product Planning (3)
*Fin 326	Problems in Financial Management (3)
Econ 346	Business Cycles and Forecasting (3)

For advanced undergraduates and graduates

269. Management of Operations in Organizations (3) fall-spring
Study of the design, operation and control of activities necessary to generate the goods or services of profit and nonprofit organizations. Includes examination of basic concepts and quantitative modes used in operations. Eco 45, Math 44. Messrs. Stevens, and Smackey.

270. Conceptual Foundations of Organizational Theory and Behavior (3) fall-spring
A study of formal organizations as ongoing systems and the behavior of people within them. Systems examined include: a bureaucratic-rationality model; a behavioral-social model; and an adaptive-contingency model.

300. Apprentice Teaching in Management (1-3) fall-spring

301. Business Management Policies (3) fall-spring
Case study of business problems and the formulation of policies, strategies and tactics to resolve those problems from the viewpoint of general management. Emphasis on long-range goal attainment, policy formulation, and administrative implementation for particular functional areas and the total firm. Prerequisites: senior standing in the College of Business and Economics, and completion of the college core.

302. Quantitative Models-Conceptual (3) fall-spring
Survey of various quantitative methodologies and their use in business, economics and other areas. Specific subject areas include: classical optimization techniques, mathematical programming, including linear programming, decision theory, game theory, simulation and network models. Prerequisites: Eco 105, Acctg 111, Mgt 269.

304. Quantitative Models-Applications (3) spring
Extension and application of selected topics covered in Mgt 302. Development of term projects to solve practical problems. Prerequisite: Mgt 302. Mr. Greenleaf.

306. Entrepreneurship and Business Policy (3) spring
A case study of the problems of creating new ventures or managing family-owned businesses. Integrates knowledge acquired in other courses and stresses development of strategic and administrative policies for particular functions and the company as a whole. Prerequisites: senior standing, completion of College of Business and Economics core and Mgt 311. Approval of department chairman. Mr. Bonge. (Students may not receive credit for both Mgt 306 and Mgt 301. Satisfies the Mgt 301 or Eco 333 core requirement.)

311. LUMAC (Management Assistance Counseling) (3) fall-spring
A field studies course primarily for business and economics majors. Students acquire experience in accounting, financial control, marketing and management under the faculty's supervision by providing management assistance to small businesses in the Lehigh Valley. Students work in small groups on a direct basis with owners. Prerequisite: junior standing in the College of Business and Economics and consent of the department chairman. Course may be repeated once for credit.

316. Organizational Decision Processes (3)
Examination of managerial decision-making processes in formal organizations. Operating decisions, negotiated decisions and strategic decisions are analyzed through individual and group activities. Primary focus on necessary imputs for effective organizational decisions. Prerequisites: Mgt 269 and Mgt 270. Messrs. Bonge and Litt.

321. Organizational Behavior Workshop
Study of psychological aspects of individual behavior, interpersonal transactions, behavioral processes in small work groups, and the entire organization as an ongoing system. Techniques include motivational analysis, role-playing, nonverbal interactions, group problem solving and organizational simulations. Prerequisite: Mgt 270 and permission of the department chairman.

331. Industrial Relations (3) fall
Interdisciplinary consideration of conflict and conflict resolution procedures in the industrial and related settings, emphasizing behavioral aspects of work roles in intergroup relationships, collective bargaining in private and public sectors, grievance machinery terminating in arbitration, mediation, fact-finding and other aspects of public emergency dispute settlement. Prerequisite: Mgt 269 or equivalent. Mr. Tripp.

371. Directed Readings (1-3)
Readings in various fields of management, designed for the student who has a special interest in some field of management not covered by the regularly scheduled courses. Prerequisite: consent of department chairman. May be repeated.

372. Special Topics (1-3)
Special problems and issues in management for which no regularly scheduled coursework exists. When offered as group study, coverage varies according to interests of instructor and students. Prerequisite: consent of department chairman. May be repeated.

For graduates

402. Operations Management (3) spring
Focus on the operations function from the perspective of general management. Emphasis is on the development of operations-related models and the formulation and implementation of operations policy in the context of the firm's over-all strategy. This course is designed to meet this background requirement of a student enrolled in the MBA program. Prerequisite: Eco 417.

412. Organization Structures and Processes (3) spring
An examination of the structure and processes of organizations. The traditional bureaucratic model of managing work and information flow is contrasted with the behavioral decision-making model of the firm. A synthesis of these perspectives is sought through a study of the contemporary theory of organization. Classroom activity centers around the discussion of research-based theories and the analysis of case problems. Prerequisites: Mgt 413 or equivalent. Mr. Bonge.

413. Organizational Behavior (3)
The study of organization behavior concepts integrated with experiential learning of selected topics such as psychological contract, motivation, interpersonal perception and communication, group structure and processes, leadership, managerial style, and organizational change. This course is designed to meet this background requirement of a student enrolled in the MBA program. Not available for students who have already taken Mgt 270 or Mgt 321.

417. (IE 417) Advanced Mathematical Programming (3)
Theory and applications of the extensions of linear programming. Tucker-Kuhn conditions, gradient methods of optimization, simplex-based methods of nonlinear programming, integer programming, branch and bound, zero-one discrete programming and stochastic programming. Prerequisite: a course in linear programming.

418. Analytical Methods in Management (3) alternate years
Application of management science methods to industrial and commercial problems. Scientific method, decision theory, linear programming, inventory control, regression analysis, forecasting, simulation, and related areas are examined in the context of accounting, finance, marketing, and manufacturing. Prerequisite: Mgt 302.

423. Corporate Enterprise: Concepts and Issues (3)
A study of contemporary social issues relevant to corporate enterprise. A framework is developed around concepts drawn from political science, economics, business history, law and the behavioral sciences and is used to analyze the benefits and social costs of corporations. Issues such as corporate power, lifestyles, work and leisure, resources and pollution, and the role of government are examined. Mr. Litt.

430. (IE 430) Management Science Project (3)
As an individual or as a member of a small group, an analysis is made of a management problem and the design of its solution is made incorporating management science techniques. An individual written report is required. Recommended that it be taken in the last semester of the M.S. in management science program.

451. Managerial Policy and Decision-Making (3) fall-spring
Integration of theory and analytic techniques through intensive investigation of complex organizational, strategic and financial problems in industrial and nonbusiness entities. A case study approach is used. Prerequisites: graduate-level exposure to accounting, economics, finance, management and marketing. An MBA candidate should take the course near the end of the MBA program. Mr. Hobbs.

471. Directed Readings (1-3)
Graduate readings in management not covered in regularly scheduled course-work. Prerequisite: consent of department chairman. May be repeated.

472. Special Topics (1-3)
Special problems and issues in management for which no regularly scheduled graduate coursework exist. When offered as group study, coverage will vary according to the interests of instructor and students. Prerequisite: consent of department chairman. May be repeated.

Marketing

Major in the College of Business and Economics

Required: fifteen credits beyond the core listed on page 37 from the following:

required courses

Mkt 213	Marketing Communications (3)
Mkt 312	Marketing Research (3)

elective courses*

Three courses (nine credit hours) from the following:

Mkt 314	Marketing and the Multi-national Firm (3)
Mkt 315	Consumer Behavior (3)
Mkt 316	Advertising (3)
Mkt 317	Industrial Marketing (3)
Mkt 319	New Product Planning (3)
Mkt 371	Directed Readings (1-3)
Mkt 372	Special Topics (1-3)

*Other approved courses may be used as marketing electives depending upon the students career orientation (Mgt 302, Eco 339, Acctg 324, Fin 326, etc.).

For advanced undergraduates and graduates

211. Contemporary Marketing (3) fall-spring
The course examines contemporary marketing from a managerial perspective. It emphasizes the design of marketing programs given the considerations of such background variables as consumer behavior, the social and cultural environment, the economic environment, market segmentation, the nature of demand, and industry structure. Prerequisite: Eco 105.

213. Marketing Communications (3) fall-spring
The course considers the communication-promotion decision processes of organizations. The effects of source, message and media variables on audience response to communication campaigns and the interactions among these variables are examined. Strong emphasis is given the promotion model consisting of the roles of personal selling, sales promotion, publicity, and advertising in marketing. Prerequisite: Mkt 211.

300. Apprentice Teaching in Marketing (1-3) fall-spring

312. Marketing Research (3) fall-spring
Use of quantitative and qualitative information in routine and nonrecurring decision-making. Topics include statistical design of marketing studies, model building, analysis of research studies, and the development of marketing information systems. Case problems and presen-

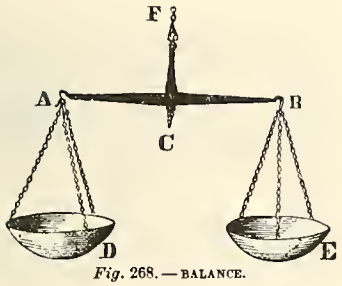

Fig. 268. — BALANCE.

tation of student research projects examine problems in communicating research results. Prerequisites: Eco 45, Mkt 211. Messrs. Hansz, Horton and Smackey.

314. Marketing and the Multinational Firm (3) spring
The course considers various methods of assessing overseas market opportunities. It evaluates the various channels a firm might utilize to distribute its products in another country including indirect export, direct export, overseas sales, subsidiary, overseas production and marketing, and the multinational firm. Students progress through each of these phases utilizing the medium of computer simulation to evaluate alternative distribution methods. Their ultimate responsibility is the design and operation of a multinational firm. Prerequisites: Fin 225 and Mkt 211. Mr. Hansz.

315. Consumer Behavior (3) fall
Examination of principal theories which the fields of psychology, social psychology, anthropology and economics contribute toward understanding the behavior and motivations of consumers. Topics include consumer needs and wants; learning theory; the perceptual process; decision-making processes; communication; search behavior; market segmentation and product differentiation; and the adoption and diffusion of innovations. Prerequisite: Mkt 211, Mkt 312. Mr. Horton.

316. Advertising (3) spring
An intensive study of advertising from a managerial perspective. The critical analysis of specific advertising campaigns and the societal implications of advertising are considered. Prerequisite: Mkt 213.

317. Industrial Marketing (3) fall
Analysis of marketing and sales problems unique to manufacturers of industrial products. Focus on organization and productivity of sales force, product line policies, pricing strategies, buyer requirements, customer service, and the use of formal proposals. Prerequisites: Mkt 211, Fin 225. Mr. Smackey.

319. New Product Planning (3) spring
An advanced marketing course specializing in the organization and management of marketing activies related to the development of new and improved products. The role of marketing research and preproduction testing in the commercialization process. Application of simulation and risk analysis to the screening of research and development projects. Prerequisites: Mkt 211, Fin 225. Mr. Smackey.

371. Directed Readings (1-3)
Readings in various fields of marketing, designed for the student who has a special interest in some field of marketing not covered in regularly scheduled courses. Prerequisite: consent of department chairman. May be repeated.

372. Special Topics (1-3)
Special problems and issues in marketing for which no regularly scheduled coursework exists. When offered as group study, coverage will vary according to the interests of the instructor and students. Prerequisite: consent of department chairman. May be repeated.

For graduates

407. Marketing Strategy (3)
An overview of the role of marketing in organizations. Particular emphasis is placed upon the design of marketing strategy, given such considerations as consumer behavior, the social-cultural environment, legal-political environment, market segmentation, the nature of demand, and industry structure. This course is designed to meet this background requirement of a student enrolled in the MBA program. Prerequisite: Eco 405.

420. Managing the Sales Effort (3)
Organizing and managing the sales staff, including selection, training, compensation, motivation and supervision. Planning, executing, and controlling aspects are emphasized. Prerequisite: graduate coursework in marketing, or the equivalent.

450. Marketing Planning and Organization (3) fall
A graduate course in marketing with an emphasis on marketing planning, marketing organization, and the impact of information on marketing decision-making. Analytical examination of pricing, product, promotion and distribution decision; development of competitive strategies. Prerequisite: Eco 405. Mr. Hansz.

471. Directed Readings (1-3)
Graduate readings in marketing not covered in regularly scheduled courses. When offered as group study, coverage varies according to the interests of the instructor and students. Prerequisite: consent of department chairman. May be repeated.

472. Special Topics (1-3)
Special problems and issues in marketing for which no regularly scheduled graduate coursework exists. When offered as group study, coverage varies according to the interests of the instructor and students. Prerequisite: consent of department chairman. May be repeated.

MATHEMATICS

Professors. Everett Pitcher, Ph.D., chairman and distinguished professor; Edward F. Assmus, Jr., Ph.D.; Dominic G.B. Edelen, Ph.D.; Bhaskar K. Ghosh, Ph.D.; Theodore Hailperin, Ph.D.; Chuan-Chih Hsiung, Ph.D.; Samir A. Khabbaz, Ph.D.; Jerry P. King, Ph.D.; Gregory T. McAllister, Ph.D.; George E. McCluskey, Ph.D.; Gilbert A. Stengle, Ph.D.; Albert Wilansky, Ph.D.

Associate professors. Bennett Eisenberg, Ph. D.; Samuel L. Gulden, M.A.; Clifford S. Queen, Ph.D.; Gerhard Rayna, Ph.D.; Murray Schechter, Ph.D.; Andrew K. Snyder, Ph.D.; David Trutt, Ph.D.

Assistant professors. Richard F. Basener, Ph.D.; Paul E. Cohen, Ph.D.; Donald M. Davis, Ph.D.; Viswanatha Raja Gopala Rao, Ph.D.

Lecturer. Joanne R. Bogart, Ph.D.

Adjunct lecturer. Richard J. Cichelli, B.S.

Mathematics is the universal language of science. The major in mathematics prepares the student to use mathematics for expressing and analyzing relationships in a wide variety of disciplines. These include the exact sciences, the social sciences, business, and pure mathematics itself. The program emphasizes fundamental principles and the mastery of techniques required for the effective use of mathematics.

Special programs can be arranged for students interested in computer science, actuarial science, statistics, or applications to other sciences.

required preliminary courses

Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)

or, in place of the three above, both of the following courses:

Math 31	Calculus (4)
Math 32	Calculus (4)

required major courses

Math 205	Linear Methods (3)
Math 219	Principles of Analysis (3)
Math 316	Complex Analysis (3)
Math 243	Algebra (3)
Math 244	Algebra (3)
	major electives (12)

Note: Approval of the electives by a designated representative of the department is required. They need not all be courses offered by the mathematics department. They must include at least one of the following: Math 307, 309, 320 and 332.

Students with an interest in applied mathematics are encouraged to choose for some of their major electives mathematically oriented 200- or 300-level courses offered by other departments.

Students interested in actuarial science are advised to include Math 230, 309, 334 and 336 among their major electives. For information on preparation for taking examinations of professional actuarial societies students may consult their mathematics adviser.

For students especially interested in computer science, the substitutions Math 208 for Math 226 and Math 317 for Math 244 are acceptable. It is suggested that their electives include some or all of the following: Math 105, 332, 362, 365, EE 241, and EE 315.

Minors in Mathematics

These are five minors offered in the department of mathematics. The courses normally required are listed below. For substitutions, consult the department chairman.

minor in pure mathematics

Math 21, 22, 23, 219, 243, and 244
Math 220 or 226

minor in probability and statistics

Fifteen credits of mathematics, including at least three of the following:
Math 42 or 231 (only one accepted for credit)
Math 201
Math 309
Math 310
Math 334

minor in actuarial science

Math 230, 231, 235,
and any two of the following:
Math 309
Math 334
Math 336

minor in computer science

Math 21, 22, 23, 105, 205,
Math 362 or 365
Math 243 or 317

minor in astronomy

Phys 11, Math 21, and Astr 2
Math 22 or Readings (Math 171 or 371) approved by the division of astronomy
Astr 211 or 221
Astr 232 or 242

Undergraduate courses

21. Analytic Geometry and Calculus I (4) UP fall-spring
Functions and graphs; limits and continuity; derivative and differential; indefinite and definite integral; logarithm and exponential.

22. Analytic Geometry and Calculus II (4) UP fall-spring
Trigonometric and hyperbolic functions; integration; vector algebra and calculus; solid analytic geometry. Prerequisite: Math 21.

23. Analytic Geometry and Calculus III (4) UP fall-spring
Series; Taylor's Theorem; approximations; partial derivatives, multiple integrals; line and surface integrals; differential equations. Prerequisite: Math 22.

Math 31 and 32 constitutes an accelerated calculus sequence which is equivalent to Math 21, 22 and 23.

31. Calculus (4) UP fall
Functions and graphs; limits and continuity; derivative and differential; indefinite and definite integral; logarithm, exponential, trigonometric and hyperbolic functions; integration; vector algebra and calculus. Math 31 may be used in place of Math 21 to satisfy prerequisites. Prerequisite: consent of department chairman.

32. Calculus (4) UP spring
Vector calculus; solid analytic geometry; series; Taylor's Theorem; approximations; partial derivatives; multiple integrals; line and surface integrals; differential equations. Math 32 may be used in place of Math 23 to satisfy prerequisites. Prerequisite: Math 31.

Math 41 through 44 are designed primarily for students of the Biological, Management, and Social Sciences. Math 44 normally should be taken in the semester following Math 41. Math 42 and 43 may each be taken at any time.

41. BMSS Calculus (3) UP fall-spring
The Riemann integral, the derivative, limits and continuous functions, the mean value theorem, the fundamental theorem of the calculus,

Fig. 442. — AMERICAN BISON, (BUFFALO.) (*Bos Americanus.*)

antiderivatives, applications of the integral, maxima and minima, infinite sequences and series, partial derivatives.

42. BMSS Probability (3) UP spring
Sets, functions, counting methods, probability spaces, conditional probability and independence, random variables, continuous probability spaces, some useful probability distributions—binomial, hypergeometric, Poisson, uniform, exponential and normal.

43. BMSS Linear Algebra (3) UP fall
Matrices, vectors, vector spaces and mathematical systems, special kinds of matrices, elementary matrix transformations, systems of linear equations, convex sets, introduction to linear programming.

44. BMSS Calculus (3) UP fall-spring
Functions of several variables, applications of partial derivatives, extreme values of functions, Lagrangian multipliers, complex variables and exponentials, Euler's formula, calculus of trigonometric functions, linear difference and differential equations, systems of linear equations, numerical solution of differential equations. Prerequisite: Math 41 or 21 or consent of department chairman.

81. Computers and Calculus (1) UP fall
Writing and testing digital computer programs to solve problems arising from the calculus. Designed for students enrolled in Math 21, 31 and 41 who are not taking another introductory course in computing. No previous knowledge of programming is assumed. Prerequisite: Math 21, 31 or 41, concurrently or previously.

82. Computers and Calculus (1) UP spring
A continuation of Math 81. Prerequisite: Math 81 or consent of department chairman.

105. Computer Programming (3) UP fall-spring
The translation of simple mathematical and logical problems into forms permitting their solution by digital computers, with emphasis on machine-language programming of several typical types of computers. Mr. Rayna.

110. (IS 110) Algorithmic Processes (3) P
The role of machines as physical models of abstract processes. Computability, practical computability, and unsolvability. Examples drawn from pure mathematics including recursive function theory and the real number system. Prerequisite: Math 23 or Math 32. Mr. Barnes.

171. Readings (1-3) UP fall-spring
Study of a topic in mathematics under individual supervision. Intended for students with specific interests in areas not covered in the listed courses. Prerequisite: consent of department chairman. May be repeated for credit.

For advanced undergraduates and graduates

For students who have not taken their elementary mathematics at Lehigh, the prerequisites for certain advanced courses are stated in terms of the number of semester hours of calculus.

201. Mathematical Models in the Social Sciences (3) UP fall, odd-numbered years
Construction and analysis of mathematical models used in biology, the social sciences and management. The models use the mathematics taught in the BMSS mathematics sequence. Prerequisites: Math 44 and a course in probability or statistics.

205. Linear Methods (3) UP fall-spring
Matrices; systems of linear equations; determinants and rank; characteristic roots; linear differential equations; eigenvalue problems; analytic functions; Bessel's equation. Designed for undergraduates in science and engineering. Prerequisite: Math 23 or Math 32.

208. Complex Variables (3) UP fall-spring
Functions of a complex variable; calculus of residues; contour integration; applications to conformal mapping and Laplace transforms. Prerequisite: Math 23, Math 32, or nine semester hours of differential and integral calculus.

219. Principles of Analysis I (3) UP fall-spring
The real number system; limits; continuous functions; differentiation; integration; infinite series. Prerequisite: Math 23, Math 32 or nine semester hours of differential and integral calculus.

220. Principles of Analysis II (3) UP fall-spring
Continuation of Math 219. Absolute and uniform convergence; functions of several variables; line and surface integrals; implicit functions. Prerequisite: Math 219.

230. Numerical Analysis (3) UP fall
Difference calculus and interpolation, numerical quadrature, numerical solution of nonlinear equations, and difference methods for ordinary differential equations. Some familiarity with a computer programming language is necessary. Prerequisite: Math 205 previously or concurrently.

231. Probability and Statistics (3) UP fall-spring
Probability and distribution of random variables; populations and random sampling; *t*, chi-square, and F distributions; estimation and tests of hypotheses; correlation and regression theory of two variables. Prerequisite: Math 23, Math 32, or nine semester hours of calculus.

235. Actuarial Science (3) UP fall, even-numbered years
Selected topics from measurement of interest, annuities, bonds, amortization schedules and sinking funds. Introduction to single-life functions. Relevant to Part III of the examination offered by the Society of Actuaries. Not an approved elective for mathematics major programs. Prerequisite: Math 231 or consent of department chairman.

243. Algebra (3) UP fall-spring
An introduction to the basic concepts of modern algebra begining with group theory and including ring theory, linear algebra, and field theory. Prerequisite: Math 205.

244. Algebra (3) UP fall-spring
A continuation of Math 243. Prerequisite: Math 243.

251. Mathematical Methods (1-4) UP
An introductory survey of topics in analysis for graduate students in fields other than mathematics. Topics may include: differential equations, techniques of series expansion, numerical methods, matrix and vector analysis, complex variables, calculus of vector fields. Formal applications are emphasized. Prerequisites: graduate standing and consent of the department chairman. With consent of the chairman, may be repeated for credit.

285. Introduction to Geometries (3) UP fall
Introduction to synthetic and analytic projective geometry with emphasis on Euclidean and non-Euclidean geometries as special cases. Some familiarity with matrices and determinants is desirable.

302. Advanced Calculus and Exterior Differential Forms (3) UP spring
Implicit function theorem, exterior algebra, exterior differential forms, Stokes' theorem. The Frobenius and Darboux theorems with applications to topics selected from partial differential equations, electromagnetic theory, classical mechanics, differential geometry, and thermodynamics. Prerequisite: Math 205.

303. Mathematical Logic (3) UP fall
A course, on a mathematically mature level, designed not only to acquaint the student with the logical techniques used in mathematics but also to present symbolic logic as an important adjunct in the study of the foundations of mathematics. Messrs. Cohen and Hailperin.

304. Axiomatic Set Theory (3) UP spring
A development of set theory from axioms; relations and functions; ordinal and cardinal arithmetic; recursion theorem; axiom of choice; independence questions. Prerequisite: Math 219 or consent of department chairman. Messrs. Cohen and Hailperin.

307. General Topology I (3) UP fall
An introductory study of topological spaces, including metric spaces, separation and countability axioms, connectedness, compactness, product spaces, quotient spaces, function spaces. Prerequisite: Math 219.

308. Algebraic Topology I (3) UP spring
Polyhedra, fundamental groups, simplicial and singular homology. Prerequisites: Math 307 and Math 327.

309. Theory of Probability (3) UP fall-spring
Probabilities on discrete and continuous sample spaces; events on a discrete sample space; random variables and probability distributions; transformations; simplest kind of law of large numbers and central limit theorem. The theory is applied to problems in physical and biological science. Prerequisite: Math 23, Math 32, or nine semester hours of differential and integral calculus. Mr. Ghosh.

310. Probability and its Applications (3) UP spring
Continuation of Math 309. Random variables, characteristic functions, limit theorems; stochastic processes, Kolmogorov equations; Markov chains, random walks; time series. Prerequisite: Math 309 or consent of department chairman. Messrs. Eisenberg and Ghosh.

316. Complex Analysis (3) UP spring
Concept of analytic function from the points of view of the Cauchy-Riemann equations, power series, complex integration, and conformal mapping. Prerequisite: Math 219.

317. (EE 317, IE 317) Analytical Methods for Information Sciences (3)
Series of topics in discrete mathematics chosen for their applicability to computer science,

coding theory, and informational retrieval. Sets; binary relations; lattices; Boolean algebras and application to logic design; semigroups and relevance to automata; groups and application to coding; fields and relevance to circuits and codes; graphs and application to file searching. Prerequisite: senior standing or consent of department chairman. Mr. Tzeng.

320. Ordinary Differential Equations (3) UP spring
The analytical and geometric theory of ordinary differential equations, including such topics as linear systems, systems in the complex plane, oscillation theory, stability theory, geometric theory of nonlinear systems, finite difference methods, general dynamical systems. Prerequisites: Math 220 previously or concurrently and Math 205.

322. Methods of Applied Analysis I (3) UP fall-spring
Fourier series, eigenfunction expansions, Sturm Liouville problems. Fourier integrals and their application to partial differential equations; special functions. Emphasis is on a wide variety of formal applications rather than logical development. Prerequisite: Math 205 or consent of department chairman.

323. Methods of Applied Analysis II (3) UP spring
Green's Functions; integral equations; variational methods; asymptotic expansions, method of saddle points; calculus of vector fields, exterior differential calculus. Prerequisite: Math 322.

327. Groups and Rings (3) UP fall
An intensive study of the concepts of group theory including the Sylow theorems, and of ring theory including unique factorization domains and polynomial rings.

332. Numerical Analysis (3) UP spring
Advanced quadrature methods, multistep methods for ordinary differential equations, and introduction to numerical methods for partial differential equations. Prerequisite: Math 230.

334. Mathematical Statistics (3) UP fall
Populations and random sampling; sampling distributions; theory of statistical estimation; criteria and methods of point and interval estimation; theory of testing statistical hypothesis; analysis of variance; nonparametric methods. Prerequisite: Math 309 or consent of department chairman. Mr. Ghosh.

336. Life Contingencies (3) UP spring, odd-numbered years
Selected topics from single-life functions (continued from Math 235), multi-life functions, and multidecrement functions. Relevant to Part IV of the examination offered by the Society of Actuaries. Prerequisites: Math 230 and Math 235, or consent of the department chairman.

342. Number Theory (3) UP
A survey of elementary and nonelementary algebraic and analytic methods in the theory of numbers. Includes the Euclidean algorithm, Diophantine equations, congruences, quadratic residues, primitive roots, number-theoretic functions as well as one or more of the following topics: distribution of primes, Pell's equation, Fermat's conjecture, partitions. Prerequisite: Math 219 or consent of department chairman. Mr. Queen.

350. Special Topics (3) UP
A course covering special topics not sufficiently covered in general courses. Prerequisite: consent of department chairman. May be repeated for credit.

361. (IS 361) Automata and Formal Grammars (3)
Study of the interaction between recognition devices and generation devices for formal languages. Comparison of automata and formal grammars of differing strengths. Application to questions of computability and decidability. Mr. Barnes.

362. Computer Languages (3) UP fall
An examination of a number of high-level computer programming languages, and of the concepts and techniques which are used in the design of the compilers which translate them. Prerequisite: Math 105 or consent of department chairman. Mr. Rayna.

365. Programming Techniques (3) UP fall
Basic ideas of structured programming and data structures. Application to recognition techniques, recursion, sorting and searching, symbolic and combinatorial processing. The computer language Pascal. Numerous programming assignments to be run on the university computer. Prior programming experience helpful but not required. Mr. Gulden.

371. Readings (3) UP
The study of a topic in mathematics under appropriate supervision; designed for the individual student who has studied extensively and whose interests lie in areas not covered in the listed courses. Prerequisite: consent of the department chairman. May be repeated for credit.

381. Probability and Statistics (3)
Combinatorial problems, theory of probability, various frequency distributions, standard deviation, sampling, correlation. Prerequisite: open to secondary school teachers who present at least eighteen hours of undergraduate mathematics.

382. Algebra (3)
Fundamentals of algebra, axiomatic method, set theory, notions of group, ring, integral domain, and field. Prerequisite: same as Math 381.

385. Higher Geometry I (3)
Logical systems, postulates, synthetic projective geometry, analytic projective geometry, affine, euclidean and non-euclidean geometry. Prerequisite: same as Math 381.

387. Intermediate Analysis (3)
The real number system, functions, limits, continuity, derivative, law of the mean, Taylor's formula, definite integral. Prerequisite: open only to secondary school teachers of mathematics who present at least eighteen semester hours of undergraduate mathematics including a course in analysis.

For graduates—mathematical program

The department of mathematics offers a graduate program in mathematics leading to the doctor of philosophy degree. The first of these degrees was awarded in 1939. In the fall of 1976 there were about fifty graduate students of mathematics, of whom about twenty-five were engaged in writing Ph.D. theses. The master of science degree in mathematics may be taken as a final degree or as an incidental step on the road to a Ph.D. degree.

To begin graduate work in mathematics, a student presents evidence of adequate study of mathematics as an undergraduate. The program should have included at least a year of advanced calculus, a semester of linear algebra, and a semester on groups, rings, and fields.

The program for the master of science degree will ordinarily include Math 307, 308, 316, 327, 401, 423 and 428. A student with unusually strong background, or specialized interests, may be permitted to make substitutions.

The master of science degree requires either a thesis or a comprehensive examination at the discretion of the department chairman. The same examination is used as the comprehensive examination for the M.S. and the qualifying examination for the Ph.D. degree. Thus it is usually required for the master of science degree for those students who plan to continue to the Ph.D. A syllabus for the examination is available.

The plan of work for the doctor of philosophy degree will ordinarily include courses in algebra, analysis, geometry, and topology at the 400 level and several courses including seminars in the field in which the dissertation is to be written. The department accepts candidates for the Ph.D. who desire to specialize in and to write a dissertation on some aspect of any of the following areas of advanced work: analysis with emphasis on pure mathematics or applied mathematics, algebra, functional analysis, differential geometry, mathematical logic, probability, statistics, and topology.

One may refer to the description of the Center for the Application of Mathematics.

For graduates—computer science program

With the cooperation of several other departments, the department of mathematics offers a program leading to the degree of master of science in computer science.

To begin work in this program, the student must have some skill in programming in a computer language such as Fortran, Algol, Basic, APL, Pascal, or Wizard, and some familiarity with the concepts of machine or assembly languages. (Math 105 can be taken, without graduate credit, to remedy deficiency in these areas.) The student also presents at least two years of college mathematics.

The program includes the following four "core courses," except as competence in the respective areas results from past courses, experience, or is demonstrated otherwise:

Math 317	Analytical Methods for Information Sciences (3)
Math 362	Computer Languages (3)
EE 241	Switching Theory and Logic Design (3)
IE 310	File Structure and Processing (3)

The student's program is to be developed in consultation with a departmental adviser, and approved by an interdepartmental committee.

Further information can be found in a brochure available from the department.

401. Real Analysis I (3) fall
Lebesgue measure and integration; differentiation; LP spaces.

402. Real Analysis II (3) spring
Continuation of Math 401. Topics such as general measure and integration theory, Radon-Nikodym theorem, Banach and Hilbert spaces, and Fourier analysis. Prerequisite: Math 401.

404. Mathematical Logic (3) spring, odd-numbered years
Topics in quantification theory relevant to formalized theories, recursive functions, Godel's incompleteness theorem; algorithms and computability. Messrs. Cohen and Hailperin.

405. Partial Differential Equations (3) fall
Classification and transformation of equations; theory of characteristics; initial and boundary value problems; Cauchy's problem for hyperbolic equations; Dirichlet's problem for elliptic equations; potential theory; Green's function; harmonic and subharmonic functions; difference equations; applications to equations of physics. Prerequisite: Math 220.

406. Partial Differential Equations (3) spring
Continuation of Math 405. Prerequisite: Math 405.

407. Transforms (3) fall
The properties and use of the Fourier transform, the Laplace transform, the finite transform and generalized functions. Prerequisites: Math 220 and either Math 208 or 316.

409. Mathematics Seminar (1-6) fall
An intensive study of some field of mathematics not offered in another course. Prerequisite: consent of department chairman.

410. Mathematics Seminar (1-6) spring
Continuation of the field of study in Math 409 or the intensive study of a different field. Prerequisite: consent of department chairman.

416. Complex Function Theory (3) fall
Continuation of Math 316. Prerequisite: Math 316 or consent of department chairman.

419. Linear Operators in Hilbert Space (3) fall
Algebra and calculus of bounded and unbounded operators on Hilbert space. Spectral analysis of self-adjoint, normal, and unitary operators. Interplay between operator theory and classical function theory emphasized. Prerequisites: Math 220, and Math 208 or 226 or 316. Mr. Trutt.

423. Differential Geometry I (3) fall
The differential geometry of curves and surfaces in Euclidean space, including problems in the large. Mr. Hsiung.

424. Differential Geometry II (3) spring
Multilinear algebra; differentiable manifolds; tensor bundles; exterior differential forms; theorems of Stokes and Frobenius; imbedding theorem; affine connections; holonomy groups; Riemannian manifolds. Prerequisites: Math 423 and 308. Mr. Hsiung.

425. Differential Geometry III (3) fall
Continuation of Math 424. Curvature tensor; manifolds of constant curvature; Gauss-Bonnet formula; completeness; harmonic forms; curvature and homology; infinitesimal transformations; conjugate points and Morse index theorem; Lie groups and Lie algebras. Prerequisite: Math 424. Mr. Hsiung.

428. Fields and Modules (3) spring
Field theory, including an introduction to Galois Theory; the theory of modules, including tensor products and classical algebras. Prerequisite: Math 327.

431. Calculus of Variations (3)
Fundamental existence theorems; necessary conditions and sufficient conditions for relative minima of single integrals; the index theorem; application to boundary value problems. Prerequisite: Math 401. Messrs. McAllister and Pitcher.

435. Functional Analysis I (3) fall
Linear topological spaces; local convexity; function spaces; inductive and weak topologies; duality, separation and extension theorems; the open mapping and uniform boundedness principles; Banach algebras; applications to classical analysis. Prerequisite: Math 307. Mr. Wilansky.

436. Functional Analysis II (3) spring
Continuation of Math 435. Prerequisite: Math 435. Mr. Wilansky.

443. General Topology II (3) spring
A continuation of Math 307, with such topics as filters and nets, topological products, local compactness, paracompactness, metrizability, uniformity, function spaces, dimension theory. Prerequisite: Math 307.

444. Algebraic Topology II (3) fall
Continuation of Math 308. Cohomology theory, products, duality. Prerequisite: Math 308.

445. Algebraic Topology III (3) spring
Homotopy theory, obstruction theory, spectral sequences. Prerequisite: Math 444.

449. Advanced Topics in Algebra (3)
An intensive study of some topics in algebra with emphasis on recent developments. May be repeated for credit. Prerequisite: consent of department chairman.

451. Measure Theory (3)
Contents chosen from such topics as: ergodic theory; measure on topological spaces; harmonic analysis on groups; invariant measures on transformation groups. May be repeated for credit. Prerequisite: Math 402.

453. Function Theory (3)
The development of one or more topics in function theory, such as analytic continuation, maximum modulus principle, conformal representation, Taylor series analysis, integral functions, Dirichlet series, functions of several complex variables. Prerequisite: Math 416.

455. Algebraic Number Theory (3)
Ideal theory, Diophantine equations, theory of locally compact fields, p-adic numbers, and cyclotomic fields. Prerequisites: Math 327 and 316, or consent of department chairman. Mr. Queen.

456. Algebraic Number Theory (3)
Continuation of Math 455, with emphasis on class field theory and analytic number theory. Prerequisite: Math 455. Mr. Queen.

Fig. 2195.
PYRULA CANALICULATA, (U. S.)

457. Summability (3)
Methods of generalization of the limiting process with classical applications. Applications of functional analysis. FK spaces. May be repeated for credit. Prerequisite: consent of department chairman.

461. Mathematical Statistics (3)
An intensive study of one or more topics not sufficiently covered in Math 334, such as theory of statistical tests, statistical estimation, regression and analysis of variance, nonparametric methods, stochastic approximation, decision theory. Prerequisites: Math 334 and 401. Mr. Ghosh.

463. Probability Theory (3)
An intensive study of one or more topics not sufficiently covered in Math 309 or 310, such as limit theorems, Markov processes, ergodic theorems, martingales, time series, stochastic integrals, potential theory. Prerequisites: Math 310 and 401. Mr. Eisenberg.

464. Mathematical Logic (3) spring, even-numbered years
Selected topics not dealt with in Math 404. With consent of department chairman, may be repeated for credit. Mr. Cohen.

466. Advanced Programming Techniques (3) spring
Continuation of Math 365. Deeper study of structured programming, data structures, backtracking, recursion. Applications of basic concepts of automata theory and formal language theory. Fundamental principles of "large program" design. Several major programming assignments using Pascal. Prerequisite: Math 365 or consent of department chairman. Mr. Gulden.

471. Homological Algebra (3)
Modules, tensor products, categories and functors, homology functors, projective and injective modules. Prerequisite: Math 428.

472. Finite Groups (3)
An intensive study of the structure of finite groups and their automorphisms. Prerequisite: Math 428.

ASTRONOMY

Professor. George E. McCluskey, Ph.D.

1. The Solar System (3) fall
A survey of our knowledge of the solar system.

2. Stellar Astronomy (3) spring
Survey of our knowledge of stars and stellar systems.

211. Stellar Structure and Evolution (3) fall, even-numbered years
Physical processes in stellar interiors. Theory of stellar evolution and interpretation of observations. Prerequisites: Math 23 or 32, previously or concurrently, and Phys 21.

221. Stellar Atmospheres (3) fall, odd-numbered years
Theory of stellar spectra. Equation of transfer, model atmospheres, chemical abundances. Prerequisites: Math 23 or 32, previously or concurrently, and Phys 21.

232. High Energy Astrophysics (3) spring, odd-numbered years
Relativistic plasmas, x-ray sources, quasars, pulsars, radio galaxies, origin and evolution of the universe, current research. Prerequisites: Math 23 or 32, previously or concurrently, and Phys 21.

242. Relativity and Cosmology (3) spring, even-numbered years
Introduction to tensor analysis. Einstein's field equations, origin and evolution of the universe, current research. Prerequisites: Math 23 or 32, previously or concurrently, and Phys 21.

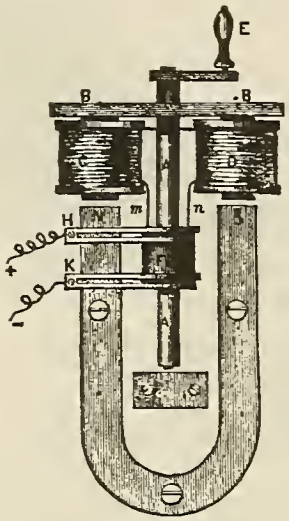

Fig. 16-2
MAGNETO-ELECTRICAL MACHINE.

MECHANICAL ENGINEERING AND MECHANICS

Professors. Ferdinand P. Beer, Ph.D., chairman; Russell E. Benner, Ph.D.; Philip A. Blythe, Ph.D.; Forbes T. Brown, Sc.D.; John C. Chen, Ph.D.; Fazil Erdogan, Ph.D.; Thomas E. Jackson, M.S.; Arturs Kalnins, Ph.D.; Edward K. Levy, Ph.D.; Alister K. Macpherson, Ph.D.; Joseph C. Osborn, M.S.; Jerzy A. Owczarek, Ph.D.; Ronald S. Rivlin, Ph.D., Centennial university professor, director, Center for the Application of Mathematics; Richard Roberts, Ph.D.; Donald O. Rockwell, Ph.D.; Robert G. Sarubbi, Ph.D.; George C.M. Sih, Ph.D., director, Institute for Fracture and Solid Mechanics; Gerald F. Smith, Ph.D.; Eric Varley, Ph.D.; Robert P. Wei, Ph.D.

Associate professors. Ronald J. Hartranft, Ph.D.; Peter D. Hilton, Ph.D.; Stanley H. Johnson, Ph.D.; Philip G. Kosky, Ph.D; Robert A. Lucas, Ph.D.; Eric P. Salathe, Ph.D.; Theodore A. Terry, Ph.D.; Dean P. Updike, Ph.D.

Assistant professor. Tony Chen, Ph.D.

Visiting professors. Vedanth Kadambi, Ph.D.; Francis T.C. Loo, Ph.D.; Mehmet B. Civelek, Ph.D.

Adjunct professors. True T. Shih; Ramu K. Sundaram.

The curriculum in mechanical engineering and mechanics consists of a common core extending through the freshman year, the sophomore year, and most of the junior year, and of a wide choice of advanced elective courses. Depending upon the program chosen, students are graduated with either the bachelor of science in mechanical engineering or the bachelor of science in engineering mechanics.

The core of the program includes courses in mathematics and the physical sciences, in mechanics of solids and fluids, in dynamics, vibrations analysis, thermodynamics, and design. Candidates for the bachelor of science in

mechanical engineering take additional courses in thermodynamics and in mechanical elements during their junior year. They should use the approved electives in their senior year to develop competence in design, system analysis and control, stress analysis, thermofluid sciences, power engineering, or some other area. Candidates for the bachelor of science in engineering mechanics must include in their program advanced courses in mathematics, dynamics and mechanics of continua. They should use the approved electives to develop additional competence in a related area, such as applied mathematics, thermofluid sciences, or materials science.

The field of mechanical engineering is wide and challenging. Conventionally mechanical engineering deals with the design and production of machines and their power sources, but the field has broadened to include many applications of the engineering sciences to a variety of engineering systems for the benefit of mankind. The mechanical engineer has played an essential role in the exploitation of new engineering frontiers such as nuclear power, cryogenic systems, rocketry, satellite guidance systems, and systems at very high and very low pressures and temperatures. Mechanical engineers are also heavily involved in solving problems of energy conversion and conservation, pollution control, and waste disposal.

On the other hand, there is a continuing demand in industry and government service for men with a broad training in the fundamentals of engineering rather than in a given specific field. Such training, in which applied mathematics and mechanics play an important part, is provided by the engineering mechanics option of this curriculum. This option emphasizes the analytical approach to engineering problems and the application of the basic methods and principles of mechanics to their solution.

Graduates in either discipline are equipped for immediate work in engineering or research and development in government service or industry. Those with ability and interest have suitable backgrounds for further studies at the graduate level.

Because of the flexibility of the curriculum, candidates for either degree may combine the study of mechanical engineering or engineering mechanics with that of other fields, such as chemical engineering, materials science, and biology, into interdisciplinary programs which will prepare them for further work in the areas of nuclear engineering, energy conversion and conservation, environmental engineering, materials science, or biomechanics.

freshman year (see page 40)

sophomore year, first semester (17 credits)

Math 23	Analytical Geometry and Calculus III (4)
Mech 1	Statics (3)
Phys 21, 22	Introductory Physics II & Lab (5)
ME 12	Engineering Drawing and Descriptive Geometry (2)
	General Studies requirement (3)

sophomore year, second semester (17 credits)

Math 205	Linear Methods (3)
ME 104	Thermodynamics I (3)
Mech 11	Mechanics of Materials (3)
ME 21	ME Laboratory I (1)
Met 91	Elements of Materials Science or
Met 63	Engineering Materials (3)
Eco 1	Economics (4)

junior year, first semester (17 credit hours)

Mech 102	Dynamics (3)
ME 105	Thermodynamics II or approved elective (3)
ME 231	Fluid Mechanics (3)
EE 160	Introduction to Electrical Engineering (4)
EE 162	Electrical Laboratory (1)
	General Studies requirement (3)

junior year, second semester (14-17 credits)

ME 101	Mechanical Engineering Design (1)
ME 151	Mechanical Elements or approved elective (3)
Mech 203	Advanced Strength of Materials (3)
CE 123	Fluid Mechanics Lab (1)
ME 242	Mechanical Vibrations (3)
Math 208	Complex Variables or
Math 231	Probability and Statistics (3) elective (0-3)*

summer

ME 100	Industrial Employment

senior year, first semester (16 credit hours)

ME 108	Laboratory I (2)
ME 102	Mechanical Engineering Design (2)
	approved electives (6)
	General Studies requirement (3)
	elective (3)

senior year, second semester (14-17 credits)

ME 109	Laboratory II (2)
	approved electives (9)
	General Studies requirement (3)
	elective (0-3)*

*Please refer to description of normal program, page 40.

Note: In the junior year, candidates for the bachelor of science in mechanical engineering take ME 105 and ME 151; candidates for the bachelor of science in engineering mechanics take Math 208.

The approved electives must represent a coherent group of approved courses such as 200- and 300-level courses in mechanical engineering and mechanics, as well as mathematics, physics, chemistry and a limited number of other fields. For candidates for the bachelor of science in mechanical engineering, six hours of approved electives are required in mechanical engineering and at least six more in mechanical engineering or mechanics.

For candidates for the bachelor of science in engineering mechanics, the following courses are required: Mech 302, Advanced Dynamics; Mech 305, Advanced Mechanics of Materials; Mech 307, Mechanics of Continua; and Math 322, Methods of Applied Analysis I.

Mechanical Engineering

Undergraduate courses

12. Engineering Drawing and Descriptive Geometry (2) fall
Engineering drawing, including sketching, machine operations, dimensioning, and tolerancing; detail and assembly drawings. Elements of descriptive geometry.

21. Mechanical Engineering Laboratory I (1)
Lectures and laboratory exercises relating to engineering laboratory technique and procedures. Includes planning, execution and analysis of tests and writing of reports. Application to measurement of mechanical properties of materials. Prerequisite: Mech 11, previously or concurrently.

100. Industrial Employment (0)
Usually following the junior year, students in the mechanical engineering or engineering mechanics curriculum are expected to do a minimum of eight weeks of practical work, preferably in the field they plan to follow after graduation. A report is required. Prerequisite: sophomore standing.

101. Mechanical Engineering Design I (1) spring
Objectives and specifications are developed for design projects to be carried out in the following semester. Alternative design concepts are proposed and oral and written reports of feasibility studies are presented.

102. Mechanical Engineering Design II (2) fall
A continuation of ME 101 in which groups are organized to do preliminary design on a previously defined project. Program organization techniques are used and laboratory testing and data acquisition are carried out as needed to promote design development. Prototypes are constructed and tested, when practical. Prerequisites: ME 101, Mech 11, ME 104.

104. Thermodynamics I (3) fall-spring
Basic concepts and principles of thermodynamics with emphasis on simple compressible substances. First and second law development, energy equations, reversibility, entropy and probability. Properties of pure substances and thermodynamic cycles. Prerequisites: Math 23, Phys 11.

105. Thermodynamics II (3) fall-spring
Equations of state, non-reacting and reacting mixtures, combustion, equilibrium of mixtures both reacting and non-reacting, statistical thermodynamic concepts. Compressible flow. Prerequisite: ME 104.

108. Laboratory I (2) fall
Lectures and laboratory exercises relating to various phases of engineering laboratory technique and procedures. Includes planning, execution, and analysis of tests and writing of reports. Prerequisite: ME 105.

109. Laboratory II (2) spring
Continuation of ME 108 with emphasis on project investigations.

110. Thesis (1-3) fall-spring
Candidates for the degree of bachelor of science in mechanical engineering may, with the approval of the director of the curriculum, undertake a thesis as a portion of the work during the senior year.

151. Mechanical Elements (3) fall-spring
Methods for the analysis and design of machine elements such as springs, gears, clutches, brakes, and bearings. Motion analysis of cams and selected mechanisms. Projects requiring the design of simple mechanisms or mechanical subassemblies. Prerequisites: Mech 11, ME 12, and Mech 102.

166. Procedures for Mechanical Design (2) spring
General design procedures, motion analysis, force analysis, static, repeated and impact types of loading, modes of failure, stress analysis, failure theories. Applications to the design of typical machine elements. Prerequisite: Mech 11.

For advanced undergraduates and graduates

231. Fluid Mechanics (3) fall-spring
Fundamental concepts. Physical similarity. Kinematics of fluid flow. Equations of flow in integral form. Equations of flow of perfect fluids. Plane irrotational flow of incompressible fluids. Navier-Stokes equation; hydrodynamic stability; turbulence. Two-dimensional boundary layers in incompressible flows; separation of flow; wakes; drag. Effects of compressibility on fluid flow. Hydraulic treatment of losses in flows in ducts. Flows with free surface. Basic measurements techniques. Prerequisite: Math 205.

242. Mechanical Vibrations (3) fall-spring
Physical modeling of vibrating systems. Linearization. Free and forced single and multiple degree of freedom systems. Simple continuous systems. Engineering applications. Prerequisites: Mech 102 or 103, Math 205.

310. Projects (1-6) fall-spring
Project work on any aspect of engineering, performed either individually or as a member of a team made up of students possibly from other disciplines. Direction of the projects may be provided by faculty from several departments and could include interaction with outside consultants and local communities and industries. Prerequisite: consent of department chairman.

312. Synthesis of Mechanisms (3) spring
Geometry and constrained plane motion with application to linkage design. Type and number synthesis. Comparison of motion analysis by graphical, analytical and computer techniques. Euler-Savary and related curvature techniques as applied to cam, gear and linkage systems. Introduction to the analysis of space mechanisms. Prerequisites: Math 205, Mech 102. Mr. Terry.

320. Thermodynamics III (3) fall
Advanced treatment of thermodynamic laws both for single element and mixtures. Phase equilibrium. Ideal solutions, chemical equilibrium. Thermodynamic cycle analysis. real fluid properties, availability. Prerequisite: ME 104. Messrs. Kosky and Macpherson.

321. Introduction to Heat Transfer (3) fall-spring
Analytical, numerical, and analog solutions to steady and transient, one- and two-dimensional conduction problems; thermal radiation, free and forced convection of laminar and turbulent character inside cylindrical tubes and over external surfaces; thermal design of heat exchangers. Prerequisites: ME 104, ME 231. Messrs. J. Chen and Levy.

322. Gas Dynamics (3) spring
Equations of flow of compressible fluids. Thermodynamic properties of gases. Shock waves. One-dimensional steady flow through ducts with variable cross-sectional area, flows with viscous friction and heat addition. Prerequisites: ME 231, ME 104, Math 205. Messrs. Owczarek and Rockwell.

324. Aerospace Propulsion Systems (3) spring
Cycle analysis of air-breathing engines. Optimum configurations for different flight regimes. Chemical and nuclear rocket engines. Component design. Prerequisite: ME 105. Mr. Jackson.

325. Vehicular Propulsion Systems (3) fall
Thermal analysis of internal combustion engines for vehicular propulsion. Component design. Unconventional propulsion systems. Applications to current problems in ground transportation. Prerequisite: ME 105. Mr. Jackson.

331. Fluid Mechanics (3) fall
Kinematics of fluid flow. Conservation equations for inviscid and viscous flows; integral forms of equations. Two-dimensional potential flow theory of incompressible fluids with applications. Boundary layers. Introduction to free shear layer and boundary layer stability and structure of turbulence. Transition from laminar to turbulent boundary layers. Separation of flow. Steady and unsteady stall. Secondary flows. Flow of non-Newtonian fluids. Hydrodynamic lubrication. Measurement techniques. Prerequisite: ME 231 or equivalent preparation. Messrs. Owczarek and Rockwell.

340. Advanced Mechanical Engineering Design (3) spring
Optimum design of mechanical components and systems. Parameter optimization by the theory of maxima and minima, geometric programming and optimum seeking methods. Automated design. Probabilistic approaches to design. Prerequisite: Math 231. Mr. Benner.

341. Mechanical Systems (3) fall
Advanced topics in mechanical systems design. Friction, wear and lubrication with applications to friction drives, journal and rolling-element bearings. Schock and vibration control in machine elements such as springs, gears and rotating discs. Rotor-bearing system dynamics. Balancing of rotating and reciprocating machines. Prerequisites: ME 151, Mech 203, and ME 242. Messrs. Benner and Erdogan.

342. Dynamics of Engineering Systems (3) fall
Dynamic analysis of mechanical, electromechanical, fluid and thermal engineering systems with emphasis on the modeling process. Survey of numerical methods with emphasis on dynamic simulation and computer practice. Prerequisite: ME 242. Mr. Johnson.

343. Control Systems (3) fall-spring
Linear analysis of mechanical, hydraulic, pneumatic, thermal and electrical feedback control systems. Transient and frequency response, root locus, stability criteria and compensation techniques. Prerequisites: Math 205 and ME 242. Messrs. Brown, Johnson and Sarubbi.

350. Special Topics (1-4)
A study of some field of mechanical engineering not covered in the general courses. Prerequisite: consent of department chairman.

360. (ChE 360) Nuclear Reactor Engineering (3) fall-spring
A consideration of the engineering problems in nuclear reactor design and operation. Topics include reactor fuels and materials, thermal aspects, instrumentation and control problems, radiation protection and shielding, fuel processing, and reactor design. Prerequisite: senior standing in engineering or physical science. Messrs. J. Chen and Clump.

For graduates

The department offers programs of study leading to the master of science and doctor of philosophy degrees in mechanical engineering. The department also participates in the College of Engineering and Physical Sciences master of engineering program. Research covers a variety of fields including fluid and solid mechanics, heat transfer, thermodynamics, energy conversion, design and system dynamics and control.

Equipment available for research includes; in thermofluids, a two-phase loop, a water tunnel, several fluidized bed facilities, a six-inch interferometer, a wind tunnel and a heat pipe flow loop; in solid mechanics, a variety of electrodynamic and servo controlled hydraulic testing machines, a photo-elastic bench and a laser; in system dynamics and control, a shaker table and mini-computer.

Some of the recent activities of the staff are listed below.

Thermofluids. Study of flow in fluid amplifiers; study of separation of boundary layers; study of unsteady flows of gases and liquids in ducts; theoretical study of atmosphere flows using finite elements; the structure of unsteady, radiation-driven, shock waves; jet flow-acoustic field interaction; three-dimensional wall jet flow; interaction of a system of jets; vortex formation in free shear layers; minimizing energy losses in decelerating flow via suction; unsteady turbulent and laminar flow in diffusers; fluid flow in porous channels with mass transfer at the walls; heat transfer in fusion reactor systems; heat transfer in nuclear reactors; combustion of coal in fluidized beds; heat transfer in fluidized beds; boiling heat transfer in petrochemical equipment; free convection heat transfer; analysis of heat pipe performance; storage and handling characteristics of solvent refined coal; measurement of possible power output from a combined wind-solar energy system; solar heating and cooling.

System dynamics and control. Transients in fluid lines; unsteady turbulent boundary layers in tubes and diffusers; dynamics of fluidic amplifiers; optimal design of fluidic operational amplifiers; modeling and simulation of dynamic engineering systems using energy methods and/or bond graphs; methods of experimental identification, modeling and analysis of distributed-parameter engineering systems; improved techniques of aircraft control system design; direct digital to hydraulic transduction methods.

A program in design leading to the master of engineering degree is available with the objectives of educating students in advanced design methods and encouraging the initiation and implementation of creative design projects. A wide range of interdisciplinary course offerings permits construction of a program in one or

several of the following areas: mechanical systems, reliability engineering, probabilistic approaches to design, mechanism synthesis, digital and analog computer-aided design, ocean engineering, bio-mechanics, optimum design, and environmental design. In addition to formal coursework, the student registers for six hours of ME 460, engineering project, and submits an acceptable report upon completion of the work.

For the master of science degree, a thesis based on a research project and carrying six credit hours is required of all candidates.

Any student who has not taken the mathematics courses required in the undergraduate mechanical engineering curriculum will be expected to make up for this deficiency in planning a graduate program. The student may then be required to present a larger number of credits than the minimum required for graduation.

Subject to proper approval, courses from other engineering curricula, such as mechanics, chemical engineering, and metallurgy and materials science, may be included in the major.

A student who plans to work for the doctorate should submit a general plan to the department chairman during the first year and arrange for the qualifying examinations.

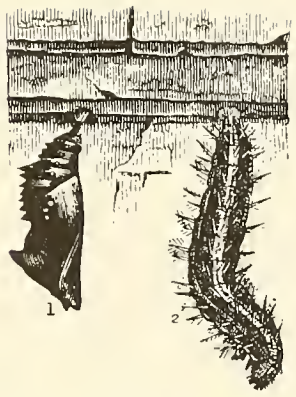

Fig. 1560.
1, chrysalis; 2, larva of the butterfly Vulcano.

420. Advanced Thermodynamics (3) spring 1978
Critical review of thermodynamics systems. Criteria for equilibrium. Applications to electromagnetic systems. Statistical thermodynamics. Irreversible thermodynamics. Thermoelectric phenomena. Messrs. Kosky and Macpherson.

421. Topics in Thermodynamics (3)
Emphasis on theoretical and experimental treatment of combustion processes including dissociation, flame temperature calculations, diffusion flames, stability and propagation; related problems in compressible flow involving one-dimensional, oblique shock waves and detonation waves. Methods of measurement and instrumentation.

424. Turbulent Flow (3) fall 1978
Stability of laminar flow; transition to turbulence. Navier-Stokes equations with turbulence. Bounded turbulent shear flows; free shear flows; statistical description of turbulence. Prerequisite: ME 331. Messrs. Macpherson, Owczarek, and Rockwell.

426. Radiative and Conductive Heat Transfer (3) fall 1977, spring 1979
Principles of radiative transfer; thermal-radiative properties of diffuse and specular surfaces; radiative exchange between bodies; radiative transport through absorbing, emitting and scattering media. Advanced topics in steady-state and transient conduction; analytical and numerical solutions; problems of combined conductive and radiative heat transfer. Prerequisite: ME 321 or ChE 421. Messrs. J. Chen and Kosky.

427. (Ch.E. 427) Multiphase Heat Transfer (3) fall 1978
Heat transfer and fluid dynamics of multiphase systems. Subcooled, nucleate, and film boiling; bubble nucleation; dynamics of bubble growth and collapse; vapor-liquid cocurrent flow regimes; two-phase pressure drop and momentum exchange, low instabilities; convective-flow boiling; simultaneous heat and mass transfer. Prerequisite: ME 321 or ChE 421. Messrs. J. Chen and Kosky.

428. Boundary Layers and Convective Heat Transfer (3) spring 1978
Navier-Stokes and energy equations, laminar boundary layer theory, analysis of friction drag, heat transfer and separation. Transition from laminar to turbulent flow. Turbulent boundary layer theory, Prandtl mixing length, turbulent friction drag, and heat transfer. Integral methods. Flow in ducts, wakes and jets. Natural convection heat transfer. Prerequisite: ME 331 or ME 321. Messrs. Levy, Owczarek and Rockwell.

431. Advanced Gas Dynamics (3) fall 1977, spring 1979
Method of characteristics. Unsteady continuous flow. Unsteady flows with discontinuities. Shock tubes. Detonation waves. Two-dimensional and axisymmetric supersonic flows. Momentum and energy equation of compressible viscous fluids. Messrs. Owczarek and Rockwell.

432. Topics in Gas Dynamics (3)
The equilibrium thermodynamic properties of a dissociating mixture of gases. Equilibrium flow of dissociating gases. Vibrational and chemical nonequilibrium. Criteria for thermodynamic equilibrium of gas flow. Chemical kinetics of gaseous reactions. Equations of flow of a reacting gas mixture. Nonequilibrium flows. Application to design of ram-jets and rocket nozzles and of reentry vehicles. Prerequisites: ME 320, ME 322.

439. Fluid Mechanics of Turbo-machinery (3)
The Euler equation. One-dimensional analysis of turbo-machinery. Performance characteristics. Limitations on performance imposed by real fluid effects. Cascade flow. Two-and three-dimensional flow. Surge and stall. Mr. Owczarek.

442. Analytical Methods in Engineering I (3) fall
Analytical methods of solution for discrete and continous engineering systems. Theoretical, numerical and approximate methods of solution applied to equilibrium, characteristic value and propagation types of engineering problems. Messrs. Erdogan, Lucas and Sarubbi.

443. Analytical Methods in Engineering II (3) spring
Continuation of ME 442.

444. Experimental Stress Analysis in Design (3)
Applications of experimental stress analysis to mechanical design problems. Messrs. Robert and Wei.

446. Mechanical Reliability (3) fall 1978
Design of mechanical engineering systems to reliability specifications. Probabilistic failure models for mechanical components. Methods for the analysis and improvement of system reliability. Effect of component tolerance and parameter variation on system failure. Reliability testing. Prerequisite: Math 231 or Math 309. Messrs. Benner and Sarubbi.

448. (E.E. 448) Optimal Control and Design Theory (3) spring 1978
Parameter optimization in design and optimal open-loop and feedback control via the extrema of unconstrained and constrained functions and functionals (calculus of variations). Matrix and state space formulation, Lagrange multipliers, Pontryagin maximum principle, Hamilton-Jacobi theory, matrix Ricatti equations, sen-

Fig. 202. — ARTESIAN WELL.

sitivity analysis. Survey of observability and controllability, dynamic programming, and Kalman filter. Intended for engineers with a variety of backgrounds. Prerequisite: ME 340 or 343 or EE 212 or ChE 286. Messrs. Brown and Johnson.

450. Special Topics (3)
An intensive study of some field of mechanical engineering not covered in more general courses.

451. Seminar (1-3)
Critical discussion of recent advances in mechanical engineering.

458. Modeling of Dynamic Systems (3) fall 1977, spring 1979
Modeling of complex linear and nonlinear energetic dynamic engineering systems. Emphasis on subdivision into multiport elements and representation by the bond graph language, using direct, energetic, and experimental methods. Field lumping. Analytical and graphical reductions. Analog, digital and hybrid simulation. Examples including mechanisms, electromechanical transducers, electric and fluid circuits, and thermal systems. Prerequisite: ME 342, or ME 343, or EE 212. Messrs. Brown and Johnson.

459. Advanced Systems Control (3)
Stochastic signals in estimation and optimal feedback control. Numerical techniques for nonlinear two-point boundary value problem. Stability and design criteria for nonlinear systems. Prerequisite: ME 448 (EE 448). Messrs. Brown and Johnson.

460. Engineering Project (1-6)
Project work on some aspect of mechanical engineering in an area of student and faculty interest. Selection and direction of the project could involve interaction with local communities or industries. Prerequisite: consent of department chairman.

Mechanics

Undergraduate courses

1. Statics (3) fall-spring
Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; centroids and centers of gravity; analysis of simple structures; internal forces in beams; friction; moments and products of inertia; method of virtual work. Prerequisites: Math 22 and Phys 11.

11. Mechanics of Materials (3) fall-spring
Strength and elasticity of materials; theory of stresses and strains; deflection of beams and shafts; torsion; buckling of struts. Prerequisites: Mech 1; Math 23, previously or concurrently.

102. Dynamics (3) fall-spring
Kinematics and kinetics of particles and rigid bodies in two and three dimensions; relative motion; work and energy; impulse and momentum. Prerequisites: Mech 1; Math 23.

103. Principles of Mechanics (4) spring
Composition and resolution of forces; equivalent force systems; equilibrium of particles and rigid bodies; friction. Kinematics and kinetics of particles and rigid bodies; relative motion; work and energy; impulse and momentum. Prerequisites: Math 23 and Phys 11.

104. Dynamics and Vibrations (3)
Kinematics and kinetics of particles and rigid bodies in two dimensions; relative motion; work and energy; impulse and momentum. Introduction to vibrations. For civil engineering students. Prerequisites: Mech 1, Math 23.

For advanced undergraduates and graduates

203. Advanced Strength of Materials (3) fall-spring
Elementary consideration of stress and strain at a point. Stress-strain relations in two dimensions. Basic equations of motion. Classical theories of failures. Analysis of simple continuum systems with applications to materials behavior phenomena. Prerequisites: Mech 11, Math 205.

302. Advanced Dynamics (3) spring
Fundamental dynamical theorems and their application to the study of the motion of particles and rigid bodies, with particular emphasis on three-dimensional motion. Use of generalized coordinates; Lagrange's equations and their applications. Prerequisites: Mech 102 or 103; Math 205. Messrs. Beer and Sarubbi.

305. Advanced Mechanics of Materials (3) fall
Selected problems of stress and strain that are governed by ordinary differential equations such as combined bending and torsion of bars, curved bars, beams on elastic foundation. Membrane analogy. Principles of indeterminate analysis. Energy methods. Prerequisites: Mech 203 or equivalent; Math 205. Messrs. Erdogan and Hilton.

307. Mechanics of Continua (3) spring
Fundamental principles of the mechanics of deformable bodies. Study of stress, velocity and acceleration fields. Compatibility equations, conservation laws. Applications to two dimensional problems in the theories of perfectly elastic materials and also perfectly plastic materials. Prerequisites: Mech 203 and 305. Messrs. Rivlin and Smith.

313. Fracture Mechanics (3) spring
Fracture behavior in solids, the Griffith theory and extensions to linear elastic fracture process models; stress analysis of cracks; generalization of fracture criteria; plasticity; subcritical crack growth, including environmental and thermal effects; fracture toughness testing; failure analysis and fracture control plans. Prerequisites: Mech 11, Math 205. Messrs. Roberts, Sih and Wei.

323. (CE. 324) Fluid Mechanics of the Ocean and Atmosphere (3) fall
Hydrostatics of the ocean and atmosphere. Vertical stability. Fluid motion in a rotating coordinate system. Geostrophic flow; ocean currents; surface and internal waves. Prerequisite: ME 231 or CE 121. Mr. Macpherson.

326. Aerodynamics (3) spring
Application of fluid dynamics to external flows. Simple exact solutions in two dimensions. Kutta condition at a trailing edge. Thin aerofoil theory, steady and unsteady flow. Lifting line theory. Flow past slender bodies. Linearized compressible flow. Far field solutions, shock formation. Prerequisites: ME 231; Math 208. Messrs. Blythe and Venkataraman.

350. Special Topics (3)
A study of some field of engineering mechanics not covered in the general courses. Prerequisite: consent of department chairman.

For graduates

The graduate courses in mechanics are open in general to students who have been graduated from a curriculum in engineering mechanics, engineering mathematics, engineering physics, civil engineering, or mechanical engineering at a recognized institution.

A candidate for the master of science degree in applied mechanics is expected to possess a thorough knowledge of undergraduate mathematics and mechanics. Math 205, 208 and 322, and Mech 302 and 305, or their equivalents, are considered prerequisites for graduate work in applied mechanics. Any of these courses which have not been taken by the student as an undergraduate should be included in the graduate program. The student may then be required to present a larger number of credits than the minimum required for graduation. A thesis carrying six credit hours is required of all candidates for the master of science degree.

Current departmental research activities of interest include programs as follows:

Continuum mechanics. Formulation of field equations and constitutive equations in nonlinear continuum mechanics. Problems in finite and linear elasticity theories. Mechanics of viscoelastic solids and fluids. Plasticity theory. Generalized continuum mechanics. Thermomechanical and electro-mechanical interactions. Stress birefringence. Wave propagation. Finite amplitude wave propagation.

Fracture mechanics. Stress analysis of media containing inclusions or perforations, including visco-elastic, nonhomogeneous, and anisotropic materials. Analysis of crack growth under static, periodic, and random loadings and environmental effects. Optimizations of fracture control. Crack propagation theories for non-linear materials. Influence of cracks on the strength of structural members.

Stochastic processes. Response of systems to stochastic inputs, including the effects of multi-dimensional fields and non-stationary processes. Prediction theory. Cumulative damage under random loads.

Thin shell analysis. Free vibration and dynamics response of elastic shells. Elastic-plastic deformations of shells upon cyclic thermal loadings. Applications of shell analysis to nuclear power plant components (pressure vessels, curved pipes), and to biological systems (eye, frog's eggs and other cells).

Fluid mechanics. Finite amplitude waves in stratified gases and fluids. Shock propagation and problems related to the sonic "boom." Nonequilibrium and low density flows. Boundary layer separation and wake models. Flows of non-Newtonian fluids in flexible tubes, with application to hemorheology. Magneto-fluid mechanics. Wing theory. Three-dimensional flow in planar nozzles and in confined jets. Dynamics of unstable jets and jet interaction processes. Behavior of jets on acoustic fields. Switching dynamics in bistable amplifers. Noise correlation studies in bounded jet flows.

Special departmental facilities of interest to the graduate student include the latest mechanical, electrodynamic and servocontrolled hydraulic testing machines.

402. Advanced Analytical Mechanics (3)
Fundamental dynamical theorems and their applications to advanced problems; generalized coordinates; Lagrange's equations; fixed and moving constraints; nonholonomic systems; Hamilton's principle; Hamilton's canonical equations; contact transformations; Hamilton-Jacobi partial differential equation. Prerequisite: Mech 302 or consent of department chairman. Messrs. Beer and Johnson.

405. Response of Systems to Random Loads (3)
Stochastic processes; correlation functions and power spectra; response of mechanical systems to one-dimensional and multidimensional random load fields; probability theory for several random variables; statistical properties of the random vibrations of mechanical systems; applications to failure prediction. Prerequisite: consent of department chairman. Messrs. Beer and Sarubbi.

Mech 406. Advanced Dynamics and Vibrations (3) fall 1978
Kinematical and mathematical preliminaries, basic notions of variational calculus; Hamilton's principle, Lagrange equations, discrete systems; dynamics of continuous systems, Sturm-Liouville theory, eigenvalue problems; transient and frequency response. There will be frequent examples of the application of these techniques to the analysis of shafts, beams, membranes, and plates. Prerequisites: ME 242 and Mech 302. Messrs. Erdogan and Sarubbi.

407. Wave Propagation in Solids (3)
Wave propagation in deformable elastic solids; problems in half-space and layered media; application of integral transformations. Mr. Erdogan.

409. Theory of Elasticity I (3) fall 1977, spring 1979
Kinematics of deformation, analysis of stress, stress-strain relations, strain energy function. Reciprocal theorem. Methods for two-dimensional boundary value problems applied to anti-plane, torsion, bending and plane problems. Approximate and numerical methods of solution. Prerequisites: Math 205; Mech 305 or equivalent course in advanced mechanics of material. Messrs. Erdogan, Hartranft and Sih.

410. Theory of Elasticity II (3)
Advanced topics in the theory of elasticity. The subject matter may vary from year to year and may include, e.g., theory of potential functions, linear thermoelasticity, dynamics of deformable media, integral transforms and complex-variable methods in classical elasticity. Problems of boundary layer type in elasticity; current developments on the micro-structure theory of elasticity. Prerequisites: Mech 409, Math. 208, or consent of department chairman.

411. (Phys. 471) Continuum Mechanics (3)
An introduction to the continuum theories of the mechanics of solids and fluids. This includes a discussion of the mechanical and thermodynamical bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the theories to specific problems are given. Messrs. Rivlin and Smith.

412. Theory of Plasticity (3) spring 1978
Time independent mechanical behavior in simple tension, compression, and torsion. Time independent stress-strain relations for materials under combined stress. Application to problems with axisymmetric stress distributions. Loading, unloading, residual stresses, shakedown. Limit theorems of perfectly plastic bodies; applications. The slip line field for plane strain; examples. Plastic analysis of structures: frames, plates, shells. Finite element approach to problems. Time-dependent mechanical behavior of materials, creep. Prerequisites: Math 205; Mech 305, or equivalent course in advanced mechanics of materials. Messrs. Kalnins and Updike.

413. Fracture Mechanics (3) fall 1978
Introduction to fracture mechanics criteria for bodies containing cracks and notches; microscopic and macroscopic analytical modeling; fracture toughness concept; test specimens; stress intensity factor evaluation of crack systems; prediction of crack trajectory and direction of initiation; dynamic loading and crack propagation; fatigue crack growth and environmental effects; brittle-ductile transition phenomenon in metals; viscoelastic behavior of polymers. Prerequisite: Mech 203, Math 208, or consent of department chairman. Messrs. Erdogan, Sih, and Wei.

415. (CE 468) Stability of Elastic Structures (3)
Basic concepts of instability of a structure; bifurcation, energy increment, snap-through, dynamic instability. Analytical and numerical methods of finding buckling loads of columns. Postbuckling deformations of cantilever column. Dynamic buckling with nonconservative forces. Effects of initial imperfections. Inelastic buckling. Buckling by torsion and flexure. Variational methods. Buckling of frames. Instability problems of thin plates and shells. Prerequisite: Math 205. Mr. Kalnins.

416. Analysis of Plates and Shells (3) fall 1977, spring 1979
Bending of rectangular and circular plates, plates under lateral loads, plates with thermal and inelastic strains, effect of in-plane forces, large deflections, buckling of plates. Geometry and governing equations of shells, shells of revolution, membrane states, edge solutions, solution by numerical integration, non-symmetric problems, buckling of shells, applications to pressure vessels. Prerequisites: Math 205, Mech 305, or equivalent course in advanced mechanics of materials. Messrs. Kalnins and Updike.

417. Mixed Boundary Value Problems in Mechanics (3)
General description of mixed boundary value problems in potential theory and solid mechanics. Solutions by dual series, dual integral equations and singular integral equations. Approximate and numerical methods. Mr. Erdogan.

418. Finite Element Method (3)
The finite element method of continua is developed from relevant energy principles. Examples from elasticity, heat transfer, and fluid mechanics are used to illustrate alternative

element choices and implementation. Applications to fracture mechanics and nonlinear phenomena are discussed. The course includes the development and use of computer programs to perform the implied calculations. Prerequisites: Mech 305 or equivalent course, and knowledge of Fortran. Mr. Hilton.

421. Fluid Mechanics (3)
Kinematics of fluid flow. Lagrangian and Eulerian descriptions. Basic conservation laws. Review of thermodynamics. Constitutive relations. Vorticity, circulation. Irrotational flow. Bernoulli theorems. Vortex motion, velocity motion, velocity potential, stream function. Potential flow in two and three dimensions. Compressible flow; sound waves, simple waves; gas dynamic discontinuities. Mr. Salathe.

422. Fluid Mechanics (3)
Similarity and dimensional analysis. Exact solution for viscous incompressible flow. Singular perturbation theory, with application to flows at low and high Reynolds number. Hydrodynamic stability. Depending on interest, additional topics from magnetohydrodynamics, kinetic theory, wing theory, turbulence, water waves, flows in flexible tubes. Prerequisite: Mech 421. Mr. Salathe.

424. Unsteady Fluid Flows (3)
Gas dynamics, finite amplitude disturbances in perfect and real gases; channel flows; three-dimensional acoustics; theories of the sonic boom. Motions in fluids with a free surface: basic hydrodynamics, small amplitude waves on deep water; ship waves; dispersive waves; shallow water gravity waves and atmospheric waves. Hemodynamics: pulsatile blood flow at high and low Reynolds number. Models of the interaction of flow with artery walls. Mr. Varley.

437. (Met 437) Dislocations and Strengths in Crystals (3)
For course description, see page 163. Messrs. Chou and Wei.

450. Special Problems (3)
An intensive study of some field of applied mechanics not covered in more general courses.

METALLURGY AND MATERIALS SCIENCE

Professors. George P. Conard, Sc.D., chairman; Joseph F. Libsch, Sc.D., Alcoa professor and vice president for research; Betzalel Avitzur, Ph.D., director, Institute for Metal Forming; Sidney R. Butler, Ph.D., coordinator, Sherman Fairchild Laboratory; Ye T. Chou, Ph.D.; Joseph I. Goldstein, Sc.D., Theodore L. Diamond professor; Walter C. Hahn, Jr.; Ph.D.; Richard W. Hertzberg, Ph.D.; R. Wayne Kraft, Ph.D., New Jersey Zinc professor; Alan W. Pense, Ph.D., William J. Priestly professor; Donald M. Smyth, Ph.D., director, Materials Research Center; Richard M. Spriggs, Ph.D., vice president for administration; Robert D. Stout, Ph.D., dean of the Graduate School; S. Kenneth Tarby, Ph.D.; David A. Thomas, Ph.D., associate director, Materials Research Center.

Associate professors. Michael R. Notis, Ph.D.; John D. Wood, Ph.D.

Assistant professor. David B. Williams, Ph.D.

Course of study

Progress in many fields of engineering depends upon discovery of new materials and a better understanding of the behavior of existing materials.

Interest in new materials for solid-state devices, for application of nuclear energy and for space technology, as well as a better understanding of the behavior of materials in the design of structures, automobiles and aircraft, plant processing equipment, electrical machinery, etc., have increased the need for people trained in the science and technology of metals and other materials.

Training for this field of engineering requires basic studies in mathematics, chemistry, physics and mechanics, plus a general background in engineering principles, followed by intensive training in the application of scientific and engineering principles to the development and use of materials in a technological society. In addition, the curriculum offers an introduction to humanistic and social studies which broaden the student's outlook and enhance professional development after graduation.

The objective of the program is to combine a fundamental understanding of the behavior of materials from the electronic, atomic, crystallographic, microstructural and macrostructural viewpoints with knowledge of the technology of materials preparation and processing. The student thus receives a broad education with emphasis on the factors which govern the mechanical, physical and chemical properties of materials to aid in the analysis, development, selection and use of materials for all types of industries.

The curriculum in metallurgy and materials science is designed to train graduates for research, development, operations, management and sales careers in industry or for graduate study in metallurgy and materials science. While some graduates go directly into metal producing companies, a large proportion serve as metallurgists or materials engineers in the chemical, electrical, transportation, communications, space and other metal and materials consumer industries. A number of students pursue graduate study for university teaching and research careers.

Special programs and opportunities include the bachelor of science in engineering and the masters in materials. The undergraduate research option and industrial option are described below.

Major requirements

Recommended sequence of courses

freshman year (see page 40)

sophomore year, first semester (16-17 credit)*

Math 23	Analytical Geometry and Calculus III (4)
Phys 21, 22	Introductory Physics III and Lab (5)
Eco 1	Economics (4)
Met 63	Engineering Materials and Processes or
Met 91	Elements of Materials Science or General Studies elective (3)
Met 10	Metallurgy Laboratory or
ME 21	Mechanical Engineering Laboratory I (1)
	either in fall or spring semester (0-1)

sophomore year, second semester (15-17 credits)*

Math 205	Linear Methods or
Math 231	Probability and Statistics (3)
EE 160	Electrical Circuits and Apparatus or
Phys 31	Introduction to Quantum Mechanics (3-4)
Mech 1	Statics (3)
	General Studies elective (3)
Met 63	Engineering Materials and Processes or
Met 91	Elements of Materials Science or General Studies elective (3)
Met 10	Metallurgy Laboratory or
ME 21	Mechanical Engineering Laboratory I (1)
	either in fall or spring semester (0-1)

*Met 10 or ME 21 and Met 63 or 91 are required for graduation and should normally be taken during the sophomore year.

junior year, first semester (15-18 credit hours)

ChE 60	Unit Operations (3)
Mech 11	Mechanics of Materials (3)
Met 207	Electronic and Crystal Structure (3)
Met 210	Metallurgical Thermodynamics (3)
	General Studies elective (3)
	elective (0-3)*

*Please refer to description of normal program, page 40.

junior year, second semester (16-17 credits)

ME 166	Procedures for Mechanical Design or
Mech 102	Dynamics (2-3)
Met 101	Professional Development (1)
Met 208	Phase Diagrams and Transformations
Met 218	Mechanical Behavior of Materials (3)
Met 304	Extractive Metallurgy I (4)
	elective (3)

summer

Met 100	Summer Employment

senior year, first semester (18 credit hours)

Met 305	Extractive Metallurgy II (3)
Met 307	Structure and Behavior of Materials (3
Met 313	Materials Fabrication (3)
	engineering science elective in chemistry
	electives (6)

senior year, second semester (15-18 credits)

Met 278	Metallurgical Reports (3)
Met 358	Selection of Materials (3)
	engineering science elective (3)**
Met	approved elective (3)
	General Studies elective (3)
	elective (0-3)*

*Please refer to description of normal program, page 40.

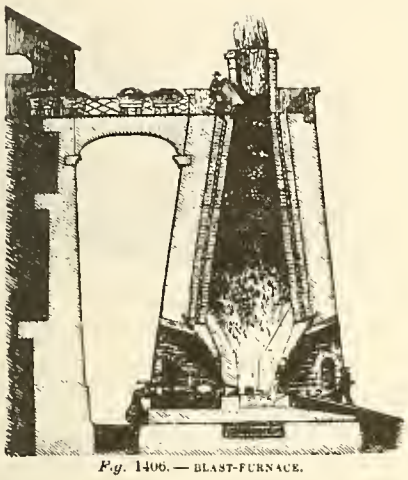

Fig. 1406. — BLAST-FURNACE.

**Engineering science electives include, for example, ChE 41, 52, 320, 321; Chem 187, 312, 393, 396; CE 106, 121, 122; IE 168, 205, 206, 212; EE 11, 20, 103; Mech 102, 203, 313; Met 312, 314, 333, 334.

In addition to the regular program, there are two options in the curriculum oriented to emphasize 1. industrial metallurgy, and 2. preparation for graduate research in materials.

Industrial metallurgy option

The industrial metallurgy option is designed to prepare students in a four-year program as plant metallurgists or materials engineers. To assist in this objective students electing the option take two special courses, Met 327 and 329, in place of an equivalent number of other specified courses. The emphasis in these courses is a team approach to the solution of actual plant problems.

The course is conducted in cooperation with local industries. Three days per week are spent at the plant of the cooperating industry on investigations of selected problems in plant operations. The option is limited to a small group of seniors selected by the department from those who apply. Summer employment is provided when possible for those who elect to initiate the program during the summer preceding the senior year.

junior year

same as regular program

summer

Met 100	Industrial Employment

senior year, first semester (17-20 credit hours)

Met 327	Industrial Metallurgy (4)
Met 329	Industrial Metallurgy (4)
Met 305	Extractive Metallurgy II (3)
Met 307	Structure and Behavior of Materials (3)
Met 313	Materials Fabrication (3)
	elective (0-3)*

senior year, second semester (17 credit hours)

Met 338	Metallurgy Colloquium (2)
Met 358	Selection of Materials (3)
Met	Approved elective (3)
	General Studies elective (3)
	engineering science elective (6)**

*Please refer to description of normal program, page 40.

**Engineering science electives include, for example, ChE 41, 52, 320, 321; Chem 187, 312, 393, 396; CE 106, 121, 122; IE 168, 205, 206, 212; EE 11, 20, 103; Mech 102, 203, 313; Met 312, 314, 333, 334.

Research option

For those students who may be interested in teaching, research, or development, and intend to pursue graduate work, a research option is offered. In this option, students take Met 240 and 291. Financial support may be available for those students who elect to initiate a research program during the summer preceding the senior year. The option is limited to a small group of selected students.

junior year, second semester (18-19 credits)
same as regular program with the following addition:

Met 240	Research Techniques (2)

summer

Met 100	Industrial Employment or Undergraduate Summer Research

senior year, first semester (15-18 credit hours)

Met 291	Experimental Metallurgy (3)
Met 305	Extractive Metallurgy II (3)
Met 307	Structure and Behavior of Materials (3)
Met 313	Materials Fabrication (3)
	elective (3-6)*

senior year, second semester (17 credit hours)

Met 338	Metallurgy Colloquium (2)
Met 358	Selection of Materials (3)
Met	Approved Elective (3)
	General Studies elective (3)
	engineering science elective (6)**

*Please refer to description of normal program, page 40.

**Engineering science electives include, for example, ChE 41, 52, 320, 321; Chem 187, 312, 393, 396; CE 106, 121, 122; IE 168, 205, 206, 212; EE 11, 20, 103; Mech 102, 203, 313; Met 312, 314, 333, 334.

Undergraduate courses

10. Metallurgy Laboratory (1) fall-spring
Application of equipment for laboratory study of structure and properties of metals. Prerequisite: Met 63 or 91 previously or concurrently.

63. Engineering Materials and Processes (3) fall-spring*
Engineering materials and their properties. Methods and effect of fabrication and treatment. Application and use of materials in engineering. Primarily metals, but including plastics, ceramics, and other engineering materials. Prerequisites: Chem 21; Phys 11 or 16.

91. Elements of Materials Science (3) fall-spring*
Introductory study of the relationship between structure (on the atomic, crystallographic or molecular, micro and macro scales) and physical and mechanical properties of metallic, ceramic, and polymeric materials. Influence of processing variables on structure and properties. Lectures and recitation. Prerequisites: Chem 21; Phys 21 or 16 previously or concurrently.

92. Structure and Properties of Materials (3) spring*
A unified chemical-physical approach to the structure and properties of metallic, nonmetallic and composite materials of construction. Laboratories and lecture examples emphasizing structure, mechanical properties, and materials applications. Prerequisites: Chem 21, Phys 21. Mr. Thomas.

**Only one of these three courses may be applied for graduation credit by each student.*

100. Industrial Employment
In the summer following the junior year students in the curriculum of metallurgy and materials science are required to secure at least eight weeks of experience in industrial plants or research organizations. A written report is required.

101. Professional Development (1) spring
Meetings with the department staff for the purpose of developing a professional outlook of the engineering student. Required reading, oral reports and term papers. Prerequisite: junior standing. Consent of department chairman required.

For advanced undergraduates and graduates

204. Nonmetallic Materials of Construction (3) spring
The principles and technology of nonmetallic materials of present and future use in civil engineering and architecture. Mechanical, environmental and physical properties of the classes of materials are related to their compositions, internal structures, and methods of manufacture. Materials include concrete, asphalt, and fiberglass-reinforced plastics. Applications include appearance and durability, thermal expansion and sealants, and acoustics. Lectures and some laboratories. Prerequisite: Mech 11 or consent of department chairman. Chemistry desirable but not required. Mr. Thomas.

207. Electronic and Crystal Structure (3) fall
Atomic theory, chemical bonding, lattice concepts, and theory of X-rays. Nature of crystalline phases, imperfections, and atom movements. Electron theories of solids. Lectures and laboratory. Prerequisites: Met 10, Mech 13 or ME 21 previously or concurrently, and Phys 21.

208. Phase Diagrams and Transformations (3) spring
Thermodynamic basis for equilibrium. The phase rule. Equilibrium phase diagrams and nonequilibrium considerations. Solidification and solid state phase changes. Rationalizations of microstructures. Recovery, recrystallization, and grain growth. Lectures and laborataory. Prerequisites: Met 207, and 210.

210. Metallurgical Thermodynamics (3) fall
The applications of thermodynamic relations to metallurgical processes with emphasis on solving specific problems for processes such as the open hearth for steel, heat treating atmospheres, alloy equilibrium diagrams, and others. Lectures and problem sections. Prerequisite: Math 23. Mr. Hahn.

213. Materials Systems Analysis (3)
Study of application of materials science principles to the solution of materials engineering problems. Interrelation between basic concepts and the selection of complete materials systems, which consist of the fabricating process and finishing sequence, for particular design requirements. Materials covered will be metals, polymers, ceramics and composites. Not open to majors in metallurgy and materials science. Lecture and laboratory. Prerequisite: Met 63 or 91 or equivalent of either course. Mr. Wood.

218. Mechanical Behavior of Materials (3) spring
Deformation and fracture behavior of materials. Elastic and plastic behavior, with emphasis on crystallographic consideration. Strengthening mechanisms in solids. Static and time dependent fracture from metallurgical and continuum viewpoints. Lectures and laboratory. Prerequisites: Mech 11, Met 207, Met 63 or Met 91. Mr. Hertzberg.

240. Research Techniques (2-3) spring
Study, analysis and application of experimental techniques in metallurgical and materials research. Analysis of experimental data and methods of presentation. Design of experimental programs. Recitations and laboratory. Restricted to small numbers of students by the department.

278. Metallurgical Reports (3) spring
An opportunity for the advanced student to develop familiarity with current metallurgical literature and to present oral reports and a comprehensive written survey. Prerequisite: senior standing.

291. Experimental Metallurgy (3)
Application of research techniques to a project in metallurgy or materials science selected in consultation with the senior staff. Prerequisite: Met 240.

300. Apprentice Teaching in Metallurgy (1-3)

304. Extractive Metallurgy I (4) spring
A unit process study of extractive metallurgy techniques. Includes chemical principles, thermochemistry and kinetics; also phases in pyrometallurgical systems, combustion of fuels and refractories. The preparation, treatment, and handling of materials for primary crude metal production. Lectures plus laboratory. Prerequisite: ChE 60, Met 210. Mr. Hahn.

305. Extractive Metallurgy II (3) fall
Continuation of Met 304. A detailed engineering analysis of important metallurgical processes. A study of the thermodynamic and kinetic aspects of these processes. Development of mathematical models of processes by computer programming. Lectures, laboratory and plant trips. A three-day inspection trip is required. Prerequisite: Met 304. Mr. Tarby.

306. Optimization of Metallurgical Processes (3)
Numerical methods are used to investigate metallurgical reactions and processes. Problems relating to the optimization of processes in the ferrous and nonferrous fields are studied. Lectures and computer-oriented problems. Prerequisites: a knowledge of computer programming and consent of department chairman. Mr. Tarby.

307. Structure and Behavior of Materials (3) fall
Correlation of structure and properties of engineering materials. Design of thermal, chemical, and mechanical treatments to develop optimum properties in metals, ceramics and polymers. Lectures and laboratory. Prerequisites: Met 218, Met 208. Mr. Pense.

311. Metallic Materials for Structures (3) fall
The structure and behavior of structural steels, aluminum and other alloys, with emphasis on materials used in large-scale engineering structures such as bridges, buildings and pressure vessels. Fracture mechanics concepts, the physical metallurgy of alloys involved, and fabrication of structures, especially welding. The relationship between materials, fracture control and fabrication. Metallurgy majors may take only with consent of department chairman. Lectures and laboratory. Prerequisite: Met 63 or equivalent. Messrs. Hertzberg and Pense.

312. (ChE 312) Fundamentals of Corrosion (3)
Corrosion phenomena and definitions. Electrochemical aspects including reaction

Fig. 356. — THE BILIARY ORGANS.

mechanisms, thermodynamics, Pourbaix diagrams, kinetics of corrosion processes, polarization, and passivity. Nonelectrochemical corrosion including mechanisms, theories, and quantitative descriptions of atmospheric corrosion. Corrosion of metals under stress. Cathodic and anodic protection, coatings, alloys, inhibitors, and passivators. Prerequisite: Met 210, Chem 187, or equivalent.

313. Materials Fabrication (3) fall
Basic concepts of stress, strain and stress-strain behavior under load. Analysis and description of metal forming, metal cutting, casting, joining, and powder metallurgy. Lectures and laboratory. Prerequisite: Met 63 or Met 91, or equivalent. Mr. Avitzur.

314. Advanced Metal Forming (3)
Extension of Met 313. Topics to be included: friction, lubrication and wear, failure and damage in metal forming, and deformation in composite metals and in powder metallurgy. Forming alternatives for specific products such as cans, tubes, wires and others will be compared. Recent developments of new forming processes. Prerequisite: Met 313. Mr. Avitzur.

315. Introduction to Physical Ceramics (3)
Methods of fabrication, physical properties, and applications of ceramic materials, including oxides, carbides, nitrides, borides and silicides. Correlation of atomic bonding, micro structure and physical behavior in service environments. Special topics, including electronic ceramics, nuclear ceramics, refractories, cutting tools and abrasives. Prerequisites: Chem 21 and Phys 11 or consent of department chairman. Mr. Butler.

316. Physical Properties of Materials (3)
Consideration of observed electrical, magnetic, thermal and optical properties of crystalline materials with emphasis on their relationship to electron configuration and crystal structure. Lectures and demonstrations. Prerequisite: Met 207 or Phys 31, or consent of department chairman. Messrs. Notis, Conard or Butler.

317. Imperfections in Crystals (3)
The types of imperfections in crystals and their effects on the behavior of crytalline materials with particular emphasis on dislocations. Prerequisite: Met 63 or 91, or equivalent. Mr. Chou.

319. Current Topics in Materials Science (3)
Selected topics of current interest in the field of materials science but not covered in the regular courses. May be repeated for credit with consent of the department chairman. Prerequisites: Met 210 and 218.

320. Analytical Methods in Materials Science (3)
Selected topics in modern analysis and their application to materials problems in such areas as thermodynamics, crystallography, deformation and fracture, and diffusion. Prerequisite: Math 231 or 205. Mr. Chou.

322. Materials Technology in the Energy Crisis (3) spring
Impact of materials on energy including nuclear and solar energy and solar cells, coal gasification, MHD power generation and superconductors. Energy resources, conversion, and consumption. Materials limitations on development of energy alternatives in transportion, power and primary metals industries. Industry and government lecturers participate. Prerequisite: Met 63 or 91, or consent of department chairman. Mr. Notis.

327. Industrial Metallurgy (4) fall
Restricted to a small group of seniors and graduate students selected by the department from those who apply. Three full days per week are spent at the plant of an area industry for research in plant operations. Application by a graduate student for admission to this course must be made prior to March 1 of the previous semester. Mr. Tarby.

329. Industrial Metallurgy (4)
To be taken concurrently with Met 327. Course material is the same as Met 327.

333. (Geol 337) X-ray Methods (3) fall
Fundamentals and experimental methods of X-ray techniques. Application to various materials problems including diffraction, radiography, fluorescent analysis. Lectures and laboratory work. Prerequisite: Phys 21, Met 91 or equivalent. Mr. Kraft.

334. (Geol 338) Electron Metallography (4) spring
Fundamentals and experimental methods in electron optical techniques included scanning electron microscopy (SEM) conventional transmission (TEM) and scanning transmission (STEM) electron microscopy. Specific topics covered will include electron optics, electron beam interactions with solids, electron diffraction and chemical microanalysis. Applications to the study of the structure of materials are given. May be repeated for credit if new material is presented. Prerequisite: consent of department chairman. Messrs. Williams and Goldstein.

338. Metallurgical Colloquium (2) spring
An opportunity for the student to develop an acquaintance with the current metallurgical literature, the ability to interpret such literature clearly, and skill in presenting oral engineering reports. Prerequisite: consent of department chairman.

343. (ChE 393, Chem 393) Physical Polymer Science (3)
Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline and paracrystalline states (including viscoelastic and relaxation behavior) for single and multicomponent systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology and behavior. Prerequisite: one year of physical chemistry.

358. Selection of Materials (3) spring
Problems relating to design and service requirements of material components. Selection of materials-fabrication, and finishing processes. Failure analysis. Discussion of specific examples involving materials. Lectures, problems. Prerequisites: Met 307 and Met 313, or consent of department chairman. Mr. Wood.

361. Physics of Materials (3)
Principles of quantum mechanics and statistical thermodynamics. Intended to provide a basic understanding of the principles underlying the study of structure and properties of materials. Prerequisites: Met 91 or equivalent; Math 205.

396. (Chem 396) Chemistry of Nonmetallic Solids (3)
Chemistry of ionic and electronic defects in nonmetallic solids and their influence on chemical and physical properties. Intrinsic and impurity-controlled defects, nonstoichiometric compounds, defect interactions. Properties to be discussed include: diffusion, sintering, ionic and electronic conductivity, solid-state reactions, and photoconductivity. Prerequisite: Chem 187 or Met 210 or equivalent. Mr. Smyth.

For graduates

The department offers four degrees: a master of science, a master of engineering, and a doctor of philosophy in metallurgy and materials science, and a master's in materials. This latter degree is part of a special five-year program which is described on page 120.

A diversity of programs and curricula are available to a person interested in graduate study in the area of materials. The department of metallurgy and materials science generally is the department from which a degree is earned. However, thesis and dissertation research may be a part of programs under way in the department or at the Materials Research Center or other departments or centers.

The department of metallurgy and materials science has both a large enough staff and graduate enrollment to enable it to suit the needs of students whose interests range from the science of materials through materials engineering and metallurgy. At the same time, those advanced students who desire it are usually provided the opportunity to gain experience in teaching under the guidance of the senior staff.

The foundation for successful graduate work in the department includes sound preparation in chemistry, physics and mathematics, and adequate breadth of general education. Candidates entering the department who have obtained their previous degrees in fields other than metallurgy or materials science may be required to take certain undergraduate courses without credit toward the graduate degree.

The programs of the department are flexible. Upon acceptance, each student is assigned a faculty adviser. Under the adviser's direction, the student plans a course of study to satisfy individual needs and interests.

Most advanced degree recipients find careers in industry or industrial or governmental research and development laboratories. A smaller number have gone into teaching, consulting or academic research.

Graduate facilities for research are located in the Whitaker Laboratory, in the interdisciplinary Materials Research Center, the Sherman Fairchild Laboratory, and other associated laboratories.

The laboratories are well equipped with both generalized equipment as well as specialized sophisticated equipment which is available to graduate students.

Specialized equipment such as conventional and scanning transmission electron microscopes, scanning electron microscope, electron microprobe, X-ray diffraction units, closed loop mechanical testing equipment, and crystal-growing and zone-processing equipment are maintained and operated by skilled technicians. After receiving the required instruction, graduate students operate this equipment.

The university supplements departmental

facilities with a centrally located CDC 6400 computer system and the Mart Library, which houses the science and engineering collections of the university.

Special programs and opportunities

The department has established specific recommended programs for the master of science or doctor of philosophy degrees, emphasizing the following areas: chemical metallurgy, materials engineering, materials science, mechanical metallurgy, physical ceramics, and physical metallurgy.

These programs are not rigid. The program in chemical metallurgy offers a cooperative "Chem.-Met." program with the chemical engineering department. The emphasis of the mechanical metallurgy program is on the analysis of metal-forming operations. Many students, however, have specialized in other areas of mechanical metallurgy, such as deformation and fracture analysis, either through combined programs in physical and mechanical metallurgy or through cooperation with the department of mechanics and mechanical engineering and the Materials Research Center. The physical ceramics program emphasizes the study of the mechanical and physical behavior of various ceramic systems.

The department also cooperates with the chemical engineering and chemistry departments in graduate programs in polymer science.

Major requirements

Graduate school requirements are explained in a special section beginning on page 43. In this department, a candidate for the degree of master of science must complete a thesis. This normally represents six of the thirty semester hours required for this degree. Candidates for the degree of master of engineering complete a three-credit engineering project.

A candidate for the Ph.D. prepares a preliminary program of courses and research providing for specialization in some phase of metallurgy, materials science, or materials engineering (largely through research) in consultation with the adviser. Prior to formal establishment of the doctoral program by the special committee and its approval by the Graduate School, the student passes a qualifying examination which must be taken early in the first year of doctoral work. The department does not require a foreign language. It does require preparation and defense of a research proposal as a portion of the general examination.

Of the courses listed above only those in the 300 series are available for graduate credit for students in metallurgy and materials science. There are many additional offerings in materials under the listings of other departments.

Most graduate students receive some form of financial aid. Several kinds of fellowships, traineeships, and assistantships are available. This type of aid generally provides for tuition, an allowance for experimental supplies, and a stipend. To date, the Internal Revenue Service has allowed this stipend to be tax-free. For details of graduate scholarships, fellowships and assistantships, please refer to the Graduate School section.

Research

Graduate students conduct their research in facilities located in the department or the Materials Research Center, or other centers and institutes. The following list of activities notes the many areas of interest and asterisks (*) indicate research of an interdisciplinary nature.

chemical metallurgy. Kinetics of metallurgical reactions; mathematical modeling of metallurgical processes; thermodynamics of metallic solutions; thermodynamics and phase equilibria.

materials science. Characterization of metal oxide films*; crystal growth*; defect chemistry and electrical properties of insulating and semiconducting oxides*; deformation and recrystallization texture studies; deformation of bicrystals; dislocation studies; eutectic research including solidification, microstructure, and property studies*; magnetic materials; meterorites and lunar materials; photoelectric studies of insulators; preparation and properties of materials for solid state devices*; processing of metal insulator semiconductor structures and their evaluation and application to integrated circuits*; quantitative metallography; structure and behavior of solid-state materials*; structure and properties of sputtered, evaporated, and plated thin films*.

mechanical metallurgy. Cladding and forming of composite materials; correlation of microstructure with mechanical behavior of low-alloy high-strength steels, especially fatigue, creep and brittle fracture; deep drawing, impact extrusion and ironing; deformation and fracture of eutectic composites; ductile fracture; effect of holes, inclusions and pressure on the tensile properties; electron fractography*; environmental crack kinetics*; fatigue crack propagation studies of metals and polymers*; flow through converging conical dies; forming of polymers*; friction measurement; hydrostatic extrusion; influence of welding on fatigue characteristics of weldments*; mechanical behavior of anisotropic materials*; pressure-induced ductility; theoretical analysis of metal forming methods and correlation with metallurgical parameters; toughness of weld metal; weldability of steels.

physical ceramics. Electrical properties of electronic ceramics*; thermal diffusivity of ceramic materials*; hot pressing studies*; grain growth in oxides*; electrical and magnetic properties of oxides*; creep modeling of ceramics*; electron microscopy of dislocation structures*; defect chemistry and electrical properties of ceramic oxides*.

physical metallurgy. Computerized materials selection; creep-rupture and aging, brittle fracture characteristics, and fatigue properties of low-alloy, high-strength steels*; diffusion-controlled growth; embrittlement mechanisms in steel; kinetics of solid state reactions*; metallurgical factors affecting machining*; physical metallurgy of aluminum alloys; physical metallurgy of sintered carbides*; recrystallization; strengthening mechanisms; structure and morphology of martensite; tempering; ternary diffusion; transformation during joining; transmission electron microscopy of crystal defects; X-ray measurement of residual stresses*.

polymers. Environmental effects on polymers to protect concrete against corrosion*; fatigue crack propagation in engineering plastics*; fracture surfaces of crystalline polymers*; ion transport in polymer membranes; mechanical behavior of interpenetrating networks*; mechanical behavior of polyvinyl chloride*; mechanisms of sintering of polymers*; micromechanics of polymer fracture*; polymers from renewable resources; properties of polymer composites*; reclamation of scrap polymeric materials*; reinforcement of silicone rubber by silica fillers*; second-order transitions in cellulose triesters*.

406. Solidification (3)
Structure, theory and properties of liquids. Homogeneous and heterogeneous nucleation theory and experimental results. Solidification phenomena in pure, single and multiphase materials including the natures of the freezing interface, segregation, constitutional supercooling, dendritic growth, crystallographic effects, the origin of defects, crystal growing, zone processes. Prerequisite: consent of department chairman. Mr. Kraft.

407. Theory of Alloy Phases (3)
Consideration of the application of the principles of thermodynamics, physics, and crystallography to the explanation and prediction of structure, physical properties and behavior of crystalline materials. Prerequisite: Met 208. Desirable preparation: Phys 363. Mr. Conard.

408. Transformations (3) fall
The thermodynamic, kinetic and phenomenological aspects of a wide spectrum of solid-state phase transformations. Theories of nucleation, growth and coarsening of second phase precipitates. Application of the theories to continuous and discontinuous reactions, massive, martensitic and bainitic transformations in metals. Transformations in nonmetallics. Prerequisites: Met 208 and 210. Mr. Williams.

409. Current Topics in Materials (3)
Recent practical and/or theoretical developments in materials. This course may be repeated for credit if new material is covered. Prerequisite: consent of department chairman.

410. Physical Chemistry of Metals I (3) fall
Discussion of reactions involving gases and reactions involving pure condensed phases and a gaseous phase. Ellingham diagrams and equilibria in metal-oxygen-carbon systems. Consideration of the behavior of solutions and methods for determining thermodynamic properties of solutions by experimentation and computation. Prerequisite: Met 210 or equivalent. Mr. Tarby.

411. Modern Joining Methods (3)
The foundations upon which the joining processes rest; the present limitations of the various processes; the trends in new developments; the engineering and structural aspects of joining. Prerequisites: Met 208 and 218. Mr. Pense.

412. Magnetic Properties of Materials (3)
Fundamental concepts of magnetism and magnetic properties of ferro- and ferrimagnetic materials. Metallic and nonmetallic materials.

Current application areas considered as examples. Prerequisite: Phys 31 or 363 or equivalent. Messrs. Butler, Conard or Notis.

413. Analysis of Metal Forming Processes (3)
Three-dimensional stress and strain analysis. Yield criteria, plastic flow and the upper and lower bound theorems. Analysis of metal forming processes, including drawing and extrusion, press work, rolling and spinning. The emphasis is on presenting several approaches to each problem. Mr. Avitzur.

414. Physical Chemistry of Metals II (3) spring
Presentation of free energy-composition and phase diagrams of binary systems. Evaluation of lattice stability parameters. Consideration of reaction equilibria in systems containing components in condensed solutions, including compound formation, oxide phases of variable composition, solubility of gases in metals. Alternative standard states and interaction parameters for solutions. Prerequisite: Met 410. Mr. Tarby.

415. Mechanical Behavior of Ceramic Solids (3)
Strength, elasticity, creep, thermal stress fracture, hardness, abrasion and high-temperature deformation characteristics of single- and multicomponent brittle ceramic solids. Statistical theories of strength, static and cyclic fatigue, crack propagation, fracture toughness. Correlation of mechanical behavior, microstructure, and processing parameters. Prerequisite: Met 218 or consent of department chairman.

416. Atom Movements (3)
Phenomenological and atomistic development of the laws of diffusion and their solution. Influence of gradients of concentration, potential, temperature and pressure. Effects of structural defects on diffusion in metals and nonmetals. Prerequisites: Math 23 and Chem. 196 or the equivalent. Messrs. Goldstein or Hahn.

417. Deformation and Strength of Solids (3)
Topics such as deformation of solids including creep, strengthening mechanisms, annealing of deformed solids, preferred orientation. Primary emphasis is on crystalline materials. May be repeated for credit if different material is covered. Prerequisite: Met 218 or equivalent. Messrs. Chou, Conard, Hertzberg, Kraft or Notis.

418. Fatigue and Fracture of Engineering Materials (3) fall
Application of fracture mechanics concepts to the fatigue and fracture of crystalline and amorphous solids. Fracture control design philosophies. Metallurgical aspects of fracture toughness and embrittlement susceptibility. Environment-enhanced cracking. Fatigue crack propagation in metals and polymers. Electron fractography. Failure analysis case histories. Prerequisite: Met 218 or equivalent. Mr. Hertzberg.

419. Alloy Steels (3)
Structures and transformations in iron and iron based alloys. Design and heat treatment of alloys for strength, toughness, creep, and corrosion resistance. Prerequisite: Met 307. Mr. Pense.

422. Electrical Properties of Materials (3)
Electrical transport properties of metallic, semiconducting and insulating materials. Brief review of energy band concepts including surface and contact effects. Photo conduction and contact phenomena. Prerequisite: Phys 31 or 363 or equivalent. Messrs. Butler, Conard or Notis.

425. Topics in Materials Processing (3)
Topics such as: ceramics, metal, and polymer synthesis and compaction phenomena. Theories of sintering and grain growth. Physical behavior of sintered compacts. Techniques of fiber and crystal growth. Vapor deposition and ultra-high-purity materials preparation. Desirable preparation: Met 208, 218, 315. Prerequisite: consent of department chairman.

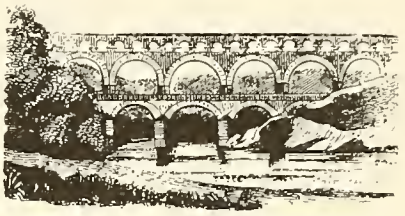

Fig. 163. — ROMAN AQUEDUCT, (*Pont-du-Gard.*)

437. (Mech 437) Dislocations and Strength in Crystals (3)
Theory and application of dislocations. Geometrical interpretation; elastic properties; force on a dislocation; dislocation interactions and reactions; multiplication. Dislocations in crystal structures. Selected topics in strengthening, plastic flow, creep, fatigue and fracture are discussed. Prerequisites: Math 205 or 221, or Met 320; Met 317, or consent of department chairman. Messrs. Chou and Wei.

443. (Chem 443) Solid State Chemistry (3)
Crystal structure, diffraction in crystals and on surfaces, bonding and energy spectra in solids, dielectrics, surface states and surface fields in crystals. Prerequisite: Chem 191 or equivalent.

458. Materials Design (3)
Analysis of design requirements for materials components. Selection of materials and processes. Study of failures in process and service and application of recent metallurgical and materials science knowledge for improved design. Solution and discussion of industrial problems, and outline of experimental approach. Prerequisite: consent of department chairman. Mr. Wood.

460. Engineering Project (1-3)
In-depth study of a problem in the area of materials engineering or design. The study is to lead to specific conclusions and be embodied in a written report. Intended for candidates for the master of engineering degree. May be repeated for a total of three credit hours.

461. Advanced Materials Research Techniques (3)
Study of the theory and application of selected advanced techniques for investigating the stucture and properties of materials. May be repeated for credit with the approval of the department chairman.

482. (Chem 482, ChE 482) Engineering Behavior of Polymers (3) spring
A treatment of the mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizers, moisture and aging on mechanical behavior.

484. (Chem 484, ChE 484) Crystalline Polymers (3) spring
An in-depth treatment of the morphology and behavior of both polymer single crystals and bulk crystallized systems. Emphasis is placed on the relationship between basic crystal physics,

thermal and annealing history, orientation and resulting properties. A detailed discussion of the thermodynamics and kinetics of transition phenomena and a brief treatment of hydrodynamic properties and their relationship to crystallization and processing properties. Prerequisites: ChE 392 or 393 or equivalent.

485. (Chem 485, ChE 485) Polymer Blends and Compositions (3) fall
An intensive study of the synthesis, morphology, and mechanical behavior of polymer blends and composites. Mechanical blends, block and graft copolymers, interpenetrating polymer networks, polymer impregnated concrete, and fiber and particulate reinforced polymers will be emphasized. Prerequisite: any introductory polymer course or equivalent.

MILITARY SCIENCE

Professor. Lt. Col. Arthur J. Phelan, M.Ed., chairman.

Associate professor. Major Roger M. John, M.A.

Assistant professors. Major Richard M. Walsh, M.A.; Capt. Harold R. Manns, M.B.A.; Capt. Donald M. Tomasik, M.S.

Instructors. SGM Joseph R. Kress; MSG Richard A. Basilici.

The Army ROTC program is designed to accomplish the following goals in the most enjoyable manner possible: develop self-confidence and innate leadership and management ability, and provide a fundamental understanding of the Army's organization and responsibility.

These goals are accomplished by utilizing numerous techniques, including academic classroom instruction, leadership laboratory, and adventure-type field trips. The leadership lab and field trips, which are based on classroom instruction, are both enjoyable and beneficial. A concept of modular electives has been instituted which permits students to select the module (activity) which most interests them. The following modules are presently available: mountaineering, survival, marksmanship, orienteering, and conflict simulations.

Voluntary field trips in all the activities are conducted throughout the year.

Army ROTC offers a four-year program and a two-year program. The four-year program consists of a two-year basic course and the two-year advanced course. Basic course students have no obligation to the United States Army by taking these classes. In other words, students in the basic course do not join the Army.

Basic Course. The basic course, normally taken in the freshmen and sophomore years, provides training in basic military subjects such as leadership and management, military history, basic tactics, marksmanship, communications, and land navigation.

Fig. 653. — COMANCHE BEARING AWAY A CAPTIVE.

Advanced course. The advanced course is normally taken in the junior and senior years. The instruction includes leadership and management, military tactics, logistics, administration, military law, and teaching methods. Students in this course receive $100 per month subsistence pay during the school year.

A six-week advanced course summer training camp is normally held between the junior and senior year. Pay for this camp is about $500 plus travel expenses. The summer camp experience, in coordination with respective engineering curricula, may be used to fulfill the requirements of the engineering courses ChE 100, CE 100, EE 100, IE 100, ME 100, and Met 100, Industrial Employment.

To enroll in the advanced course, an applicant must: 1. complete either the basic course or the six-week basic summer camp; 2. be accepted for enrollment by the university and the Army ROTC (department of military science).

Uniforms and equipment. All uniforms, textbooks and equipment needed by the student for military science courses are supplied by the department. Students are charged for those items not returned at the appropriate date.

Transfers. Qualified students transferring from another institution may enter the ROTC program at the appropriate advanced level and year, providing the individuals have received the necessary credits, the recommendation of their former professor of military science (if applicable), and the approval of the university.

Obligation after graduation. Usually upon graduation a student will receive a reserve commission as a second lieutenant and will be required to serve on active duty for three years and then three years in a reserve status. Depending on Army requirements, a three- to six-month active duty for training with an eight-year reserve commitment is offered. Recipients of a Regular Army commission must serve at least three years on active duty. Scholarship students agree to accept a Regular Army commission if offered and also serve four years on active duty. Graduates accepted for the Army aviation program serve at least three years on active duty after completing the Army Aviation School at Fort Rucker, Alabama.

Graduate studies. Under normal circumstances ROTC graduates may delay their active service to pursue a full-time course of instruction leading to an advanced degree. This delay status does not lengthen the active service obligation unless the degree is obtained at government expense.

Course credit. Students in the College of Arts and Science and the College of Business and Economics may substitute military science advanced credits for six hours of electives. In the College of Engineering and Physical Sciences, six credits of advanced ROTC work are permissible within the normal program of each student, irrespective of curriculum. For curricula which include more than six hours of personal electives in the junior and senior years, inclusion of more than six hours of ROTC credit within normal programs can be effected only with the approval of academic advisers. Two credit hours may be allowed for apprentice teaching in addition to the six hours of electives aforementioned. All military science credits apply toward the student's over-all cumulative academic average.

Career opportunities. Individuals are commissioned as officers in the United States Army after completion of the ROTC program, the advanced camp, and their university degree requirements. The majority then qualify for active duty in the Army in branches (specialties) such as the Corps of Engineers, military intelligence, ordinance, finance, field artillery, armor, infantry, medical service corps, or seven other major fields. Officers can work as leaders, specialists, or combinations of the two depending on the assignment.

There are opportunities for advanced military and civilian schooling beginning with a nearly three-month course in the branch specialty. A person can also receive one alternate specialty in such areas as, systems analysis, information, foreign area specialization, comptroller, or aviation. Upon graduation students have a choice of active duty or active duty for training only (ADT). The ADT option provides the student with the opportunity to maintain the options of a military or civilian career upon completion of the program. Those individuals who receive the ADT option become officers in the Army Reserves or Army National Guard in their hometown area and essentially have a part-time job. An officer can earn retirement through both programs after twenty years of service.

Physical facilities. Army ROTC uses the South Mountain area adjoining the fraternities and Sayre Park Field. This location is excellent for most outdoor activities such as orienteering, patrolling, and survival training. Fort Indiantown Gap Army Post, east of Harrisburg, Pa., is used for some field training exercises and weapons familiarization during the two annual trips there. Pennsylvania Army National Guard helicopters are normally used for aviation orientation and transportation in the fall en route to and from Indiantown Gap.

Special programs and opportunities

ROTC scholarship program. This program is designed to offer financial assistance to outstanding young men and women entering the ROTC program who are interested in an Army career. Each scholarship provides free tuition, textbooks and laboratory fees, in addition to pay of $100 per month for the period the scholarship is in effect. Three-, two-, and one-year scholarships are available to outstanding cadets who are currently enrolled in the four-year ROTC program and are completing either their freshman, sophomore, or junior years of college. Four-year scholarships are open to all students entering ROTC as freshmen.

Applications must be made to Headquarters, First ROTC Region, Fort Bragg, N.C. 28307, during the junior or senior year of high school. This may be done as early as the spring semester of the junior year, but not later than December 15 of the senior year.

Modular programs. Modular instruction of five to six weeks of leadership laboratory are available to individuals by their selection of choices from such as survival, orienteering, or conflicts simulations training. Another choice can normally be made from mountaineering, weapons, or Soviet Block instruction. See references to leadership laboratory above for details.

Two-Year Program. Students desiring to enroll in ROTC at a time after their sophomore year may apply. Applicants must successfully complete a six-week basic summer camp and have two years of undergraduate or graduate studies remaining. The student is paid for the six-week encampment and receives transportation costs to and from the camp. Individuals start in the advanced course after the basic camp.

Distinguished military graduate (DMG) program. This is a competitive program which permits outstanding ROTC students to apply for a Regular Army commission immediately upon graduation. At the end of the junior year and upon completion of the advanced summer camp, approximately one-third of each junior ROTC class may be designated as distinguished military students (DMS). A student who maintains the same high standards throughout the senior year may qualify for designation as a distinguished military graduate (DMG) and may be offered a Regular Army commission upon graduation. Regular Army officers basically have tenure for active duty.

Major requirements

Individuals must either complete the two- or four-year programs, attend the advanced camp, and receive a college degree to become commissioned officers in the U.S. Army.

Course descriptions

Leadership laboratory is conducted for all courses together on Monday afternoons. The students organize, plan and run their own training. Students (primarily sophomores and juniors) are the leaders of any exercise or instructional module. Individuals choose electives for about half of this training. Examples of these electives are the fall modular blocks of five periods where a student can pick conflicts simulations (war gaming), survival training, or orienteering (a cross between hiking, map reading, and cross country). Spring modular selections currently available are mountaineering, weapons training, or Soviet Block (instruction on the attitude, culture, tactics, and equipment of the Soviet soldier). Patrolling is normally taken by the majority of the corps at the start of the fall semester.

It is an excellent vehicle for leadership and management practical experience. It also stresses working together as a team. Springtime leadership laboratories stress testing, situational analysis, and decision making under stress during field problems tests of a tactical nature. Most students of all classes have opportunities to be the leader during the latter training.

13. Basic Military Science (1) fall (usually freshman year)
Examines the purpose and organization of the Army and ROTC so a student can see where he or she might fit. Leadership and management at a basic level are discussed. One recitation period plus an hour-and-a-half laboratory per week.

14. Basic Military Science (1) spring (usually freshman year)
Examines an introduction to tactics, basic use of a map and compass, and instruction in marksmanship techniques. One recitation period and two hours of leadership laboratory per week.

98. Basic Military Science (2) spring
This course is a consolidation of MS 13 and 14 into one semester.

21. Basic Military Science (2) fall (usually sophomore year).
Land navigation, including use of the compass, small-unit military tactics and operations, military communications, and the organization and functions of basic military teams. Two recitation periods and an hour and a half of leadership laboratory per week.

22. Basic Military Science (2) spring (usually sophomore year)
Primarily a study of the application of the principles of war observed in American military history. Includes special techniques in land navigation. Two recitation periods and an hour and a half of leadership laboratory per week.

105. Advanced Military Science (1) fall (usually junior year).
Examines the roles, missions and job opportunities of the various branches of the Army. It also covers the principles of military instruction. Two recitation periods and an hour and a half of leadership laboratory per week.

106. Advanced Military Science (2) spring (usually junior year)
Covers the psychological and sociological aspects of leadership and management oriented to the junior leader. Tactics at a platoon level. Three recitation periods and an hour and a half of leadership laboratory per week.

Advanced ROTC Summer Camp
This is a six-week training program conducted at Fort Bragg, N.C. Prerequisites are completion of the basic military science courses or their equivalent and M.S. 105 and 106. Under special circumstances and upon approval of the department chairman, this camp may be delayed until after graduation or completion of the advanced course. The summer camp experience, in coordination with respective engineering curricula, may be used to fulfill the Industrial Employment requirements of the engineering courses ChE 100, CE 100, EE 100, IE 100, ME 100, and Met 100.

107. Advanced Military Science (2) fall (usually senior year)
A study of how the military team works together via planning, organization, and coordination on both logistical and tactical means. Covers military law and military intelligence gathering. Three recitations and leadership laboratory.

108. Advanced Military Science (1) spring (usually senior year).
Considers the responsibilities of an officer on active duty, the position of the U.S. in our world, and the military implications of world change. Two recitation periods and leadership laboratory.

300. Apprentice Teaching in Military Science (2) fall-spring.
Enrollment limited to selected MS IV students approved by the department chairman.

MODERN FOREIGN LANGUAGES AND LITERATURE

Professors. Joseph A. Maurer, Ph.D., chairman pro tem; Anna P. Herz, Ph.D.; Victor M. Valenzuela, Ph.D.; John A. Van Eerde, Ph.D.

Associate professors. Arthur P. Gardner, Ph.D.; Anje C. van der Naald, Ph.D.; D. Alexander Waldenrath, Ph.D.

Assistant professors. Allen E. Hye, Ph.D.; Safeta S. Juka, Dr. d'Univ.; Linda S. Lefkowitz, Ph.D.; Marian M. Masiuk, Ph.D.

Majors and minors are offered in French, German and Spanish; a minor is offered in Russian.

Required language and literature courses constitute a core around which the student can build a program of studies providing a broad and sound understanding of foreign cultures as part of the culture of the Western world.

Each candidate is assigned a departmental adviser to correlate and integrate supplementary reading and study to meet special objectives.

All foreign language candidates are urged to participate in "junior year abroad" programs. Six scholarships for study abroad are offered by the department each academic year. Each is valued at $1,000.

The minimum requirement for the major is twenty-four credit hours. The candidate for the major is expected to gain a knowledge of literature and an adequate command of the language.

Specific courses other than those listed should include collateral work in ancient and modern European history, fine arts, music, and the languages and literature of other peoples.

The sequence of courses offered in any of the modern foreign languages is of particular relevance as preparation for careers in teaching and foreign service.

An interdisciplinary major combining a specialized field with a program of Russian language and literature studies is available.

French

required preliminary courses

French 3	Elementary French (4)
French 4	Intermediate French (4)
French 13, 14	Advanced French (6)

required major courses Twenty-four hours to be chosen from courses above French 14.

Undergraduate courses

3. Elementary French (4) fall
Basic conversational French illustrating essential grammatical principles, reading of simple texts and writing; some laboratory.

4. Intermediate French (4) spring
A continuation of French 3. Prerequisite: French 3, or Achievement Test score before entrance, or consent of department chairman.

13. Advanced French (3) fall
A review of grammar but an emphasis on speaking and writing on topics affording an opportunity to master the current idiom through the use of materials of contemporary interest. Prerequisite: French 4, or Achievement Test score before entrance, or consent of department chairman.

14. Advanced French (3) spring
Emphasis on readings and discussion. Prerequisite: French 13, or Achievement Test score before entrance, or consent of department chairman.

43. French Oral and Written Composition (3) fall
For students who desire an opportunity for intensive practice in the oral and written use of French. Prerequisites: French 14, or consent of department chairman, or Achievement Test score of 600. Ms. Masiuk.

44. French Oral and Written Composition (3) spring
Designed to aid students who have already satisfied the language requirement in French to develop an advanced degree of skill in speaking and writing the language. Ms. Masiuk.

46. Practical and Business French (3)
Selected readings on such current topics as public relations, the origin and role of banks, the industrial society, strikes, the Common Market. Practice in writing French for business. Conducted in French. Prerequisite: French 13, or consent of department chairman. Ms. Juka.

47. Writing and Stylistics (3) UP fall
Practice in writing by means of studying the style of French authors. Prerequisite: French 44.

51. A Survey of French Literature (3) UP fall
Training in the ability to read and understand representative works from the Middle Ages to the 19th century. Outside reading. Conducted in French. Prerequisites: French 14 or consent of department chairman. Mr. Van Eerde.

52. A Survey of French Literature (3) UP
Reading and discussion of representative works of the 19th and 20th centuries. Outside reading. Conducted in French. Prerequisites: French 51 or consent of department chairman. Mr. Van Eerde.

53. Balzac (3) UP
Conducted in French. Prerequisite: French 14 or consent of department chairman. Ms. Juka.

54. Malraux (3) UP
Conducted in French. Prerequisite; French 14 or consent of department chairman. Ms. Juka.

55. Medieval French Literature (3) UP
Introduction to Old French and reading of significant texts: La Chanson de Roland, the Lais of Marie de France, Chretien de Troyes, the romances. Conducted in French. Prerequisite: French 14, or consent of department chairman. Ms. Masiuk.

56. Late Medieval and Renaissance Literature (3) UP
Rabelais, Montaigne, the "Pleiade," and other poets; the "Conteurs." Conducted in French. Prerequisite French 14, or consent of department chairman. Ms. Masiuk.

61. Seventeenth-Century French Literature (3) UP
A study of the main preclassical and classical French writers of the 17th century. Lectures, discussion of texts, and collateral reading. Conducted in French. Prerequisite; French 14 or consent of department chairman. Mr. Van Eerde.

62. Seventeenth-Century French Literature (3) UP
Continuation of French 61. Conducted in French. Prerequisite: French 61 or consent of department chairman. Mr. Van Eerde.

63. Eighteenth-Century French Literature (3) UP
The literature of the Enlightenment and pre-Romanticism. Lectures, discussion of texts, reports, and collateral readings. Conducted in French. Prerequisite: French 14 or consent of department chairman. Mr. Van Eerde.

64. Eighteenth-Century French Literature (3) UP
Continuation of French 63. Prerequisite: French 63, or consent of department chairman. Mr. Van Eerde.

65. Nineteenth-Century French Literature (3) UP
Main literary currents of the 19th century; Romanticism and Realism. Lectures, reports, collateral readings. Prerequisites: French 14 or consent of department chairman. Ms. Juka.

66. Nineteenth-Century French Literature (3) UP
Continuation of French 65. Prerequisite: French 65, or consent of department chairman. Ms. Juka.

67. Twentieth-Century French Literature (3) UP
A study of the principal novelists of the 20th century in France: Proust, Gide, Mauriac, Sartre, Camus, Robbe-Grillet, Beckett; with a consideration of the trends, philosophy, and movements they represent. Conducted in French. Prerequisite: French 14 or consent of department chairman. Ms. Juka.

68. Twentieth-Century French Literature (3) UP
A study of the drama and poetry of 20th century France with readings chosen to illustrate the principal dramatists and poets as well as literary movements. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Ms. Juka.

81. French Cultural Program (3-6)
A summer program abroad. Includes formal instruction in the French language as well as direct contact with the French people and their culture during two months in France.

For advanced undergraduates and graduates

A student desiring to qualify for a master's degree in modern foreign languages and literature should have an undergraduate major or its equivalent in French. Those with undergraduate deficiencies, though otherwise qualified, may be admitted with the stipulation that they make up such deficiencies in addition to satisfying the minimum requirements for the degree.

The graduate major consists of a minimum of

eighteen credit hours, fifteen of which are to be selected from the department's 400-level course offerings. The student may choose to submit a thesis representing the equivalent of a maximum of six hours of coursework. If desired, the candidate is permitted to take collateral work in related fields to the extent of twelve semester hours. At the end of the course work, the student takes a comprehensive examination.

271. Readings (3) UP
A study of the works of some author or group of authors, or of a period. Prerequisite: French 14 or consent of department chairman.

272. Readings (3) UP
Continuation of French 271. Prerequisite: French 271 or consent of department chairman.

301. French Civilization (3)
Development of France from prehistoric times through the 17th century; political history, changes in social structure, literature, art. Conducted in French. Prerequisite: French 51, 52 or consent of department chairman. Ms. Juka.

302. French Civilization (3)
Continuation of French 301 for the 18th, 19th, and 20th centuries. Conducted in French. Prerequisite French 51, 52 or consent of department chairman. Ms. Juka.

307. Baudelaire (3)
The major works in prose and poetry of Baudelaire with an emphasis on theme and influence. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Ms. Juka.

308. Symbolism (3)
An intensive study of the symbolist school of poetry following Baudelaire through Mallarme and the end of the 19th century. Prerequisite: French 51-52 or consent of department chairman. Ms. Juka.

309. Advanced Medieval French Literature (3)
Introduction to Old French including readings from La Chanson de Roland, Marie de France's Lais, the Arthurian romances. Emphasis on the lyric poetry and the Arthurian tradition of the 12th and 13th centuries. Conducted in French. Prerequisite: French 51-52, or consent of department chairman. Ms. Masiuk.

311. French Classicism (3)
A study of the French classical theatre, novel, and criticism with emphasis on Corneille, Racine, Moliere, Madame de Lafayette, Malherbe, and Boileau. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Mr. Van Eerde.

312. French Classicism (3)
Continuation of French 311. Conducted in French. Prerequisite: French 311 or consent of department chairman. Mr. Van Eerde.

313. The Age of Enlightenment (3)
A study of the "Philosophes" and "Encyclopedistes" of the 18th century, with emphasis on Voltaire, Rousseau, Montesquieu, and Diderot. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Mr. Van Eerde.

314. The Age of Enlightenment (3)
Continuation of French 313. Conducted in French. Prerequisite: French 313 or consent of department chairman. Mr. Van Eerde.

Fig. 708. — ANCIENT CATHEDRAL OF CRACOW.

317. The Romantic Movement (3)
A study and analysis of the Romantic movement in France with readings chosen from its principal exponents. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Ms. Juka.

318. Theatre in the Twentieth Century (3)
Contemporary French drama with an analysis of its origins and movements. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Ms. Juka.

319. The New Novel (3)
A study of current trends in the novel in France with representative readings. Conducted in French. Prerequisite: French 51-52 or consent of department chairman. Ms. Juka.

323. From the Romantic Novel to the Present (3)
Stendhal, Balzac, Flaubert, Proust, Gide, Malraux, Sartre, Camus, Robbe-Grillet. Conducted in French. Prerequisite: French 51-52, or consent of department chairman. Ms. Juka.

331. French Poets of the Twentieth Century (3)
The leading poets from Valery to Bonnefoy. Conducted in French. Prerequisite: consent of department chairman or two semesters of French literature in college. Ms. Juka.

333. The Great Women Writers of France (3)
Women writers of France from the Middle Ages to the present. Conducted in French. Prerequisite: consent of department chairman or two semesters of French literature in college. Mr. Van Eerde.

381. French Cultural Program (3-6)
A summer program in France offering formal language courses and cultural opportunities to graduate students and teachers of French.

402. Surrealism to Structuralism (3)
Breton, Aragon, Sartre, Camus, Levy-Strauss. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman. Ms. Juka.

411. Voltaire (3)
Representative readings. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman. Mr. Van Eerde.

412. Stendhal and Flaubert (3)
The major works of Stendhal and Flaubert with particular consideration to style, theme and influence. Conducted in French. Prerequisite: 300-level course or equivalent, or consent of department chairman. Ms. Juka.

415. Proust and Gide (3)
Selected readings in Proust and Gide with particular consideration to style, theme and influence. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman. Ms. Juka.

416. Sartre and Camus (3)
A study of the plays and novels of Sartre and Camus with particular consideration to their philosophies and relation to the current literary trends. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman. Ms. Juka.

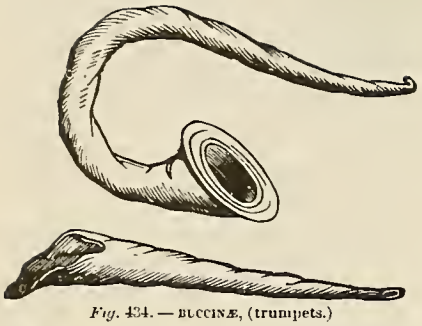

Fig. 434. — BUCCINÆ, (trumpets.)

417. Moliere (3)
A study of Moliere's most significant plays with special reference to staging, technique, and influence. Conducted in French. Prerequisite: consent of department chairman or a 300-level course in French literature. Mr. Van Eerde.

418. Writings of Jean-Jacques Rousseau (3)
An emphasis on Rousseau and pre-Romanticism. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman. Mr. Van Eerde.

420. Surrealism (3)
The contributions of Breton, Aragon, Eluard, Desnos and others. Relations between painting and poetry. Conducted in French. Prerequisite: consent of department chairman or a 300-level course in French literature. Ms. Juka.

422 French Satirical Literature (3)
A survey from the Middle Ages to the present. Conducted in French. Prerequisite: consent of department chairman or a 300-level course in French literature. Mr. Van Eerde.

424. Rabelais and Montaigne (3)
The principal works of Rabelais, and the *Essais* of Montaigne. Emphasis upon concepts of "renaissance" and "humanism." Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman. Ms. Masiuk.

431. Lyric Poetry of the 12th and 13th Centuries (3) fall
Representative poets of the period. Conducted in French. Prerequisite: a 300-level course.

432. The Roman de la Rose (3) spring
Intensive analysis of the romance. Prerequisite: a 300-level course.

491. Independent Study (1-3)
Special topics to supplement other study for the master of arts degree. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman.

492. Independent Study (1-3)
Special topics to supplement other study for the master of arts degree. Conducted in French. Prerequisite: a 300-level course or equivalent, or consent of department chairman.

German

major program

Twenty-four credits beyond German 12, of which at least nine are required at the 300 level.

minor program

Fifteen credits beyond German 12. At least nine credits are required at the 200-300 level; of these nine, at least three must be at the 300 level.

Undergraduate courses

1. Elementary German (3) fall-spring
Fundamentals of German grammar; pronunciation; simple conversation and composition; reading of simple texts. No previous German required.

2. Elementary German (3) fall-spring
Continuation of German 1. Prerequisite: German 1, or two units of entrance German, or consent of department chairman.

11. Intermediate German (3) fall-spring
Review of grammar; composition; reading and discussion of intermediate texts.
German 2 or two units of entrance German or consent of department chairman.

12. Intermediate German (3) fall-spring.
Continuation of German 11. Prerequisite: German 11 or consent of department chairman.

51. German Literature in Translation (3) UP
Study of a selected period or theme in German literature. Conducted in English. Does not count as a language course.

63. Introduction to German Culture (3) UP
Lectures, readings, and discussion of selected aspects of German Culture. Prerequisite: German 12 or equivalent, or consent of department chairman.

65. Introduction to the German Literary Tradition (3) UP
Study of representative works from the major periods of German literature. Prerequisite: German 12 or equivalent, or consent of department chairman.

67. Conversation and Composition (3) UP
Intensive practice in oral and written German. Prerequisite: German 12.

141. Development of the German Lied Since the 18th Century (3) UP
Special emphasis on the intimate relationship between the music and the text. Knowledge of German desirable but not required. Conducted in English. Prerequisite: German 2 or consent of department chairman. Mr. Gardner.

For advanced undergraduates and graduates

A student desiring to qualify for a master's degree should have an undergraduate major or its equivalent in German. Those with undergraduate deficiencies, though otherwise qualified, may be admitted with a stipulation that they make up such deficiencies, in addition to satisfying the minimum requirements for the degree.

The successful completion of ten semester courses (thirty credit hours) is required for the master of arts degree. A thesis may be offered in lieu of two semester courses (six credit hours). Collateral graduate work in other departments may be taken upon consultation with the department chairman.

The prerequisite for all 200 and 300 courses offered in German is one course beyond the intermediate level, or equivalent, or consent of chairman.

213. Introduction to the German Lyric (3) UP
Study of the nature of the lyric as a genre of literature with readings chiefly in the lyric poetry written during the Age of Goethe (from Klopstock to the Romantics), but also with the reading of poems by some representative poets from the earlier periods of German literature. Mr. Gardner.

218. Eighteenth-Century German Literature (3) UP
Survey of major works of the Enlightenment, Sturm und Drang, and the Classical Period. Mr. Waldenrath.

220. Twentieth-Century German Literature (3) UP
Survey from Naturalism up to the present. Introduction to literary innovations of the 20th century, and study of leading German, Austrian and Swiss writers. Mr. Hye.

233. Pennsylvania German Culture (3) UP
Study of the cultural contributions of Pennsylvania Germans: their history, literature, art, music and politics. Conducted in English. Mr. Waldenrath.

250. Special Topics (1-3)
Study of literary and linguistic topics not covered in regular courses. May be repeated for credit.

301. Middle High German (3)
Introduction to the language and readings in medieval literature. Mr. Gardner.

303. German Romanticism (3)
Early and late Romanticists. Mr. Waldenrath.

305. German Literature from Naturalism to Expressionism (3) alternate years
Study of works by representative writers from 1885 to 1925. Mr. Gardner.

323. The Scientist in Modern German Literature (3)
Literature that reveals the conflict between the scientist's desire to uncover the secrets of the world and the moral and philosophical implications of his findings.

325. Nineteenth-Century German Literature I (3) UP
German literature from Eichendorff through Stifter.

326. Nineteenth-Century German Literature II (3) UP
German literature from Keller through Fontane.

341. Advanced Conversation and Composition (3) alternating years
For undergraduates and teachers.

344. The Age of Goethe (3)
Selected works from Klopstock to Holderlin, with special emphasis on Herder, Goethe and Schiller. Mr. Waldenrath.

345. Goethe's Faust (3)
Readings of Goethe's play with an introduction to the Faust tradition.

352. Survey of Older German Literature (3)
Older German literature from the beginnings through the Baroque.

421. Renaissance and Baroque (3)
German literature from *Der Ackermann aus Bohmen* to the Age of Enlightenment.

432. Lessing and the Enlightenment (3)
Discussion and analysis of the literature in the pre-Classical Age. Mr. Waldenrath.

451. Nineteenth-Century German Lyric Poets (3)
Study of the lyric poetry from Heine through C. F. Meyer. Mr Gardner.

452. Twentieth-Century German Lyric Poets (3)
Study of lyric poetry from Nietzsche and Liliencron through the Expressionists. Mr. Gardner.

461. Twentieth-Century Prose (3)
Study of German prose from Naturalism to the present. Mr. Hye.

462. Twentieth-Century Drama (3)
Study of leading German, Austrian and Swiss dramatists from Naturalism to the present. Mr. Hye.

471. Independent Study (3)
Research of an author or area of German literature.

472. Independent Study (3)
Research of an author or area of German literature.

Italian

1. Elementary Italian (3) fall, alternate years
Grammar; composition; rapid reading of easy modern prose. No previous study of Italian required. Mr. Van Eerde.

2. Elementary Italian (3) spring, alternate years
Continuation of Italian 1. Prerequisite: Italian 1. Mr. Van Eerde.

11. Intermediate Italian (3)
The age of Dante. Lectures in English on Dante and his contemporaries; readings in the *Divina Commedia*. Prerequisite: one year of college Italian or two units of entrance Italian. Mr. Van Eerde.

12. Intermediate Italian (3)
The Romantic Period; lectures in English, and selected readings from the works of Manzoni and Leopardi. Prerequisite: one year of college Italian or two units of entrance Italian. Mr. Van Eerde.

Russian

1. Elementary Russian (3) fall
Classroom and laboratory introduction to the fundamentals of conversational and grammatical patterns; practice in pronunciation, simple conversation, reading and writing.

2. Elementary Russian (3) spring
Continuation of Russian 1. Prerequisite: Russian 1 or two units of entrance Russian.

11. Intermediate Russian (3) fall
Classroom and laboratory practice in conversation. Development of reading and writing skills. Prerequisite: Russian 2 or three units of entrance Russian, or consent of department chairman.

12. Intermediate Russian (3) spring
Continuation of Russian 11. Prerequisite: Russian 2 or 11, or three units of entrance Russian, or consent of department chairman.

31. Russian in Science, Economics, and Industry I (3) fall
Readings and conversations about nonliterary topics including the social and natural sciences, business, economics, industry. Prerequisite: Russian 12 or consent of department chairman.

32. Russian in Science, Economics, and Industry II (3) spring
Continuation of Russian 31. Prerequisite: Russian 12, or 31, or consent of department chairman.

41. Conversation and Composition (3) fall
Intensive practice in oral and written Russian; laboratory practice in aural comprehension. Readings and discussions on Russian literature and culture. Prerequisite: Russian 12, or three units of entrance Russian, or consent of department chairman.

42. Conversation and Composition (3) spring
Continuation of Russian 41. Prerequisite: Russian 41 or consent of department chairman.

61. Russian Literature and Culture, A (3) UP
fall, alternating years
Study of major customs, institutions and literary contributions to western civilization. No knowledge of Russian required.

62. Russian Literature and Culture, B (3) UP
spring, alternating years
Continuation of Russian 61. No knowledge of Russian required.

251. Special Topics (3) UP
Intensive study of literary or linguistic topics. Prerequisite: Russian 42, or consent of department chairman.

252. Special Topics (3) UP
Continuation of Russian 251. Prerequisite: Russian 251, or consent of department chairman.

341. Russian Realism (3) fall, alternating years.
Selected works by the Russian realists of the 19th century including Dostoevsky, Turgenev, Tolstoy. Lectures and class discussion in English; collateral reading and written reports either in Russian or in English. No knowledge of Russian is required.

343. Contemporary Soviet Literature (3) spring, alternating years
The development of socialist realism in Russian literature since 1917. Lectures and class discussion in English; collateral reading and written reports either in Russian or in English. No knowledge of Russian is required.

Spanish

required preliminary courses

Span 1	Elementary Spanish (3)
Span 2	Elementary Spanish (3)
Span 11	Intermediate Spanish (3)
Span 12	Intermediate Spanish (3)

required courses in major

Twenty-four hours above Spanish 12 of which at least six are from courses at the 200 or 300 level.

Undergraduate Courses

1. Elementary Spanish (5) fall
Basic conversational Spanish illustrating essential grammatical principles, reading of simple texts and writing.

2. Elementary Spanish (3) spring
A continuation of Span 1. Prerequisite: Span 1.

11. Intermediate Spanish (3) fall
Review of grammar; practice in speaking and writing, using materials of contemporary interest. Prerequisite: Span 2.

12. Intermediate Spanish (3) spring
Continuation of Span 11. Emphasis on readings and discussion. Prerequisite: Span 11.

13. Development of Language Skills (3) fall
Pronunciation drills; contact with native speakers from different parts of the Spanish-speaking world; use of language laboratory facilities; participation in class discussions on themes of contemporary interest. Prerequisite: Span 12.

141. Advanced Spanish Grammar and Composition (3) UP fall
Prerequisite: Span 12.

142. Advanced Conversational Spanish (3) UP spring
Prerequisite: Span 12.

151. Cultural Evolution of Spain (3) UP fall
The historical and cultural evolution of Spain from its beginning to the present. Conducted in Spanish. Prerequisite: Span 12.

152. Cultural Evolution of Latin America (3) UP spring
The historical and cultural evolution of Latin America. Conducted in Spanish. Prerequisite: Span 151.

162. Women Writers of Latin America (3)UP spring, alternate years
An examination of the contributions of women writers to Latin American literature. Conducted in Spanish. Prerequisite: Span 152.

271. Independent Study (3)
A study of the works of some author or group of authors or of a period. Prerequisite: consent of chairman.

272. Independent Study (3)
A study of the works of some author or group of authors or of a period. Prerequisite: consent of chairman.

301. The Spanish Essay (3) alternate years
Reading and discussion of outstanding thinkers from the 18th century to the present. Conducted in Spanish. Prerequisite: Span 151.

302. The Latin American Essay (3) alternate years
Reading and discussion of distinguished Spanish-American essayists of the 20th century with emphasis on the works of Rodo, Vasconcelos, Vaz Ferreira, and Francisco Romero. Oral and written reports. Conducted in Spanish. Prerequisite: Span. 152.

303. Don Quijote (3)
Reading and critical analysis. Conducted in Spanish. Prerequisite: Span. 151.

305. Spanish Literature of the Middle Ages (3)
Reading and discussion of outstanding works such as: *El Cid, El Libro de Buen Amor, La Celestina.* Topics will vary. Conducted in Spanish. Prerequisite: Span 151.

306. Existentialism and the Latin American Novel (3) alternate years
Reading and discussion of representative works of contemporary Latin American novelists. Conducted in Spanish. Prerequisite: Span 152.

308. Peninsular Literature Since 1939 (3)
Reading and discussion of representative contemporary Spanish poets, playwrights and novelists. Conducted in Spanish. Prerequisite: Span 151.

310. Literature of 19th-Century Spain (3)
Poetry, novels, and plays that exemplify the literary movements of Romanticism, Realism and Naturalism. Topics vary. Conducted in Spanish. Prerequisite: Span 151.

315. Nineteenth-Century Spanish Theater (3)
Prerequisite: Span 151.

317. Twentieth-Century Spanish Theater (3)
Prerequisite: Span 151.

331. Spanish American Literature (3) alternate years
Reading and discussion of representative works of the literature of the pre-Columbian, conquest and colonial periods. Oral and written reports. Conducted in Spanish. Prerequisite: Span 151.

333. The Novel of the Mexican Revolution (3)
Reading and discussion of representative novels. Conducted in Spanish. Prerequisite: Span 152.

334. Drama and Theater in Latin America (3)
Reading and discussion of representative plays of the 19th and 20th centuries. Conducted in Spanish. Prerequisite: Span 152.

351. Fifteenth-Seventeenth Century Peninsular Literature (3)
Historical, cultural and literary analysis of prose and poetry. Topics vary. Conducted in Spanish. Prerequisite: Span 151.

353. Development of the Novel in Spain (3)
Caballeresque, Picaresque, Sentimental, Moorish and Pastoral novels from the 14th to the 17th century. Topics vary. Conducted in Spanish. Prerequisite: Span 151.

355. Improvisational Theater Games in Spanish (3)
For students who have some fluency in the language and who welcome an opportunity to practice and improve their oral Spanish in the creative setting of improvisational theater games. Conducted in Spanish. Enrollment limited to 14. Prerequisite: third-year level fluency.

357. Women Novelists and Playwrights of Latin America (3)
Reading and discussion of outstanding contemporary works by Latin American women. Conducted in Spanish. Prerequisite: Span 152.

412. Neruda and Mistral (3)
A study of the representative works of these authors. Conducted in Spanish. Prerequisite: a 300-level course.

413. Ruben Dario (3)
A study of the poetry of Ruben Dario and his relation to the "Modernismo" movement. Conducted in Spanish. Prerequisite: a 300-level course.

416. Spanish Theater of the 17th Century (3)
The development of the Spanish drama of the Golden Age. Conducted in Spanish. Prerequisite: a 300-level course.

417. Seminar on Galdos (3)
Study of his major works. Conducted in Spanish. Prerequisite: a 300-level course.

418. Seminar on Borges and Cortazar (3)
A study of the life and works of Jorge L. Borges and Julio Cortazar. Conducted in Spanish. Prerequisite: a 300-level course.

423. The Literature of Puerto Rico (3)
Reading and discussion of representative writers. Conducted in Spanish. Prerequisite: a 300-level course.

481. Literature of the Spanish Golden Age (3)
Topics vary. Conducted in Spanish. Prerequisite: a 300-level course.

491. Independent Study (3)
Special topics to supplement other study for the master of arts degree. Conducted in Spanish. Prerequisite: consent of department chairman.

492. Independent Study (3)
Special topics to supplement other study for the master of arts degree. Conducted in Spanish. Prerequisite: consent of department chairman.

MUSIC

Professor. Robert B. Cutler, M.A., chairman.
Assistant professors. Jerry T. Bidlack, M.A.; James E. Brown, M.A.
Instructor. Kathryn Louise Reichard, A.M.

The department of music offers instruction in music history, theory and performance. With the approval of the department, a student may major or minor in music.

Admission to the band, choruses, ensembles and orchestra is by audition, and students receive credit by registering for the appropriate course in the series Music 21-68. Although there is no limit to the number of courses in this series which a student may take, students should check carefully with their advisers to determine the value of the courses as graduation credit. For example, a maximum of eight credits may be applied toward graduation in the College of Arts and Science. None of these apply toward the college humanities distribution requirement.

Private lessons may be arranged through the music department at set fees. The cost of lessons is not included in tuition.

Concert series

Music at Lehigh is a series of free professional concerts sponsered by the music department. This series of concerts is administered by a committee of students and faculty of the department. Among the artists heard recently are the Goldovsky Opera Company, the Philadelphia Composers Forum, the Cincinnati Early Music Consort, the Mostovoy Soloists and the Nu Liberation Art Unit. In addition to this series there are frequent concerts by Lehigh's own choral and instrumental performing groups.

Course offerings in music

20. Introduction to Musical Literature (3)P
An approach to musical style through the study

of works by representative composers from 1600 to the present. Mr. Cutler.

21-28. Band (1)

31-38. Chamber Singers (1)

41-48. Ensembles (1)

51-58. Glee Club (1)

61-68. Orchestra (1)

71-78. Private Study (1)
Private instrumental or vocal study with instructors who are approved by the department. Prerequisite: consent of department chairman.

Fig. 755. — ANCIENT CYMBALS AND TAMBOURINE.

81. Fundamentals (3) P
Study of melody, harmony, rhythm, and timbre as the essential elements of music. Practical exercises in dictation, sight-singing, keyboard harmony and composition. Prerequisite: some prior knowledge of music and consent of department chairman.

82. Fundamentals (3) P
Continuation of Music 81. Prerequisite: Music 81 or equivalent.

141. Sacred Choral Music (3)
The functional aspects of choral music and its relationship to the church, beginning with Gregorian Chant. Compositions of the Renaissance and Baroque masters are studied, with special attention given to the works of Bach. A survey is made of the outstanding sacred choral works of the 18th, 19th and 20th centuries, observing the shift in emphasis from the church to the concert hall. Prerequisite: consent of department chairman. Mr. Cutler.

142. Chamber Music (3)
A survey of works for smaller instrumental ensembles from the forerunners of Haydn to Stravinsky. Prerequisite: consent of department chairman. Mr. Cutler.

143. Keyboard Music (3)
Study of keyboard music with particular reference to the styles of Scarlatti, Bach, Mozart, Beethoven, Chopin and Bartok; demonstration of performance techniques on the various instruments; description of the mechanics of keyboard instruments, such as the organ, harpsichord, and piano. Prerequisite: consent of department chairman. Mr. Cutler.

147. Opera (3)
Study of three significant operas from the standard literature. Field trips to performances when possible. Prerequisite: ability to read piano-vocal score and Music 81-82 or equivalent. Mr. Bidlack.

148. Symphony (3)
Study of symphonic literature from the 18th century to the present. Prerequisite: Music 81-82 or equivalent. Mr. Bidlack.

149. Orchestration (3)
Study of traditional orchestration practice from 1600 to the present. Practical projects in orchestration using performing groups as laboratory. Prerequisite: Music 81-82 or equivalent. Mr. Bidlack.

150. Score Reading and Conducting (3)
Building skills necessary for the study and interpretation of the music scores. Intensive work at the piano with transposition, clefs, and full score reduction. Study of basic conducting patterns. Prerequisite: consent of department chairman. Mr. Bidlaek.

151. Twentieth-Century Music (3)
Analysis of selected works from Debussy to the present; particular attention to postromanticism, Stravinsky, serialism, electronic music, and the music-aesthetic of John Cage. Prerequisites: familiarity with musical notation and Music 81-82 or equivalent. Mr. Brown.

153. Electronic Music (3)
A series of projects using techniques to modify existing sounds, to create synthesized sounds, and to record sounds. Composition of tape music. Prerequisite: consent of department chairman. Mr. Brown.

154. Electronic Music (3)
Continuation of Music 153. Prerequisite: Music 153 or equivalent. Mr. Brown.

181. Composition (1-3)
Applications of the principles of Music 81-82 to compositional practice. Prerequisite: Music 81-82 or equivalent. Mr. Brown.

182. Composition (1-3)
Continuation of Music 181. Prerequisite: Music 181 or equivalent. Mr. Brown.

251. Special Topics (1-3)
Study of musical topics or work in musical composition not covered in regular courses, or continuation of study of topics or of projects in composition begun in regular courses. May be repeated for credit. Prerequisite: consent of department chairman.

NATURAL SCIENCE

J. Donald Ryan, Ph.D., director of the natural science program.

This major provides students with a broad background in the fundamentals of mathematics and science and the opportunity to concentrate to a reasonable degree in one area of science.

The program is designed especially for 1. those students who desire preparation for graduate work or careers in certain of the derivative or interdisciplinary sciences or related professional fields (oceanography, astronomy, psycho-physiology, geophysics, informatin science, medicine or dentistry, conservation, etc.), 2. those students who plan to teach in secondary schools or community colleges, and 3. those students without fixed career objectives who desire undergraduate training in science.

Students who register for the program are required to select an area of concentration (or option) which must be approved by the dean of the College of Arts and Science and the director of the program. The option may be chosen in chemistry, biology, geology, psychology, or in

an approved interdisciplinary area (geophysics, marine science, biochemistry, information science, etc.). Courses included in the option will be worked out individually for the student by the major adviser.

A special program leading to a bachelor of arts in natural science and a master of science in materials is available for interested students. See Five-Year Programs.

Qualified students may be given permission at the end of the junior year to enter a program whereby they are able to begin work toward a graduate degree (M.A., M.S., or M.Ed.) during the senior year. Students enrolled in this program often will be able to complete all requirements for the master's degree with one year of study beyond the baccalaureate.

required preliminary courses

Math 21, 22, 23	Analytical Geometry and Calculus (12)
Phys 11, 12	Introductory Physics I & Lab (5)
Phys 21, 22	Introductory Physics II & Lab (5) or
Phys 13, 14	General Physics (4)
Chem 21, 22	Introductory Chemical Principles & Lab (5)
Geol 1, 2	Principles of Geology (4) or
Astron 1	The Solar System (3)
Biol 21, 22	Principles of Biology (4) or
Psych 3	Psychology as a Natural Science (3)

required major courses

Chem 51, 52, 53, 54	Organic Chemistry or
Chem 91, 190	Physical Chemistry (6–10)
Math	elective (3)
	option (24)

Note: Math elective and courses included in option taken with the approval of major adviser.

Students registered for this major normally are expected to choose their option no later than the second semester of the sophomore year.

PHILOSOPHY

Professors. Robert F. Barnes, Jr., Ph.D.; Thomas M. Haynes, Ph.D.; Norman P. Melchert, Ph.D.

Associate professor. J. Ralph Lindgren, Ph.D., chairman.

Assistant professor. John E. Hare, Ph.D.

Instructor. Adele E. Laslie, M.A.

Students considering extensive study in philosophy, whether as a major, a major in conjunction with a minor in another field such as fundamentals of business, or as a minor, need answers to two main questions: What is the field of philosophy like? And what career possibilities are there for someone who majors or minors in philosophy? This description tries to give brief answers to these questions.

Philosophically inclined thinkers have always asked fundamental questions about the intellectual, moral, religious, social, and political aspects of human life. They have tried to subject these issues to rigorous analysis and provide thoughtful answers relevant to their time. The major current contexts for philosophical inquiry are the nature and place of moral values in contemporary life, the dysfunction of social and political institutions, the impact of technology, and the challenge of the scientific world view.

These lead to such questions as: What is the relation of the individual to the state and its laws? Which human lifestyles and institutions are conceptually viable in a technological society? What are the implications of the scientific world picture for our concepts of religion, freedom, and creativity? The analysis of the component issues in these and many more problems, the unearthing of presuppositions, the proposal of answers, and the critique of those proposals are the actual elements of philosophical investigation.

The study of philosophy provides preparation for a variety of careers either immediately after graduation or after further study beyond the bachelor degree. Careers requiring further study for which philosophy is an especially suitable preparation include: academic philosophy; law; some types of government service, e.g., urban planning; certain careers in business, e.g., management consulting, personnel and industrial relations; the ministry; academic careers in areas other than philosophy, e.g., intellectual history, religion studies, social and political theory, and information systems; and primary and secondary education.

Students majoring or minoring in philosophy who are not considering such fields find a wide variety of careers open to them after graduation. Capable philosophy students who choose their electives wisely find that the analytical, logical and discursive skills provided by philosophical training enable them to successfully pursue careers after graduation in such fields as communications, publishing, insurance, marketing, merchandising, social services, advertising, transportation and utilities. This is especially true for students who combine a major in philosophy with a minor in fundamentals of business.

The curriculum of both the major and the minor in philosophy provides both ample flexibility for tailoring course work in philosophy to the developing interests of each student and wide latitude for supplementing these studies with work in other disciplines. The aim of these curricula is to enable each student, working closely with the departmental adviser, to develop a total curriculum in the light of individual interests and aspirations.

The minor in philosophy consists of fifteen hours of coursework. The specific courses to be taken by a student in this program are decided jointly by the student and the departmental adviser. These ordinarily include at least one course at the introductory level and one at the advanced level. Minor programs may be either of a general character or organized around a special theme such as: the philosophy of science, logic, ethics and value theory, the history of philosophy, and social philosophy.

The major in philosophy consists of thirty hours of course work. Again, the specific courses to be taken by each student are decided jointly by the student and the departmental adviser. In the case of the major, the following minimum constraints are observed:

Fig. 1573. — HANES.

Required courses

Phil 14 Foundations of Logic (3)
Phil 15 Ethics (3)

plus three of the following
Phil 131 Ancient Philosophy (3)
Phil 133 Medieval Philosophy (3)
Phil 135 17th-and 18th-Century Philosophy (3)
Phil 137 19th-Century Philosophy (3)
Phil 139 20th-Century Philosophy (3)

An additional fifteen hours is selected with the counsel and approval of the adviser. At least nine of these fifteen hours are at the 200 level or above. Normally these will be courses in the philosophy curriculum, although substitutions of courses from other departments may be made with the approval of the adviser. At the discretion of the department, a major may be required to take and pass Engl 71: Expository Writing Workshop.

Undergraduate courses

10. Introduction to Philosophy (3) P fall-spring
Basic philosophical questions, perennial and contemporary, such as the objectivity of morals, the justification of government, the place of mind and feeling in a world of matter and energy, the nature of knowledge and truth, and the reality of God.

13. Practical Logic (3) P fall
Reaching conclusions and justifiying conclusions—two kinds of reasoning. The role of logic in problem solving and decision-making processes. Comparison of deductive and inductive reasoning and justification. Practice in analysis, criticism, evaluation and construction of arguments. Emphasis on developing practical ability, with material drawn from real-life contexts. Mr. Barnes.

14. Foundations of Logic (3) UP spring
The development of several symbolic languages as theroretical models for explaining certain logical features of ordinary English discourse, such as valid inference and necessary truth. Some significant general properties of these symbolic languages are studied. Mr. Barnes.

15. Ethics (3) P fall-spring
Development of the ability to thoughtfully formulate one's own moral orientation and to understand those of others through a critical study of major ethical theories such as rationalism, formalism, utilitarianism, and existentialism. Special attention is directed to such topics as moral character, judgment and responsibility. Mr. Haynes.

42. The Scientific Process (3) P spring
Study of the generation and acceptance of scientific concepts and laws, especially the contributions of theory, metaphysics, and value. Case studies in the history of science illustrate the logic of this intellectual activity. Ms. Laslie.

75. (Psych 75) Behavior Control and Human Values (3) P fall
Philosophical examination of operant conditioning techniques for controlling behavior. Value problems related to autonomy of individual choice, responsibility, rationality, freedom and dignity, and punishment. To what end shall behavior be controlled, and who will control the controllers? Prerequisite: an introductory course in either psychology or philosophy, or consent of department chairman. Messrs. Melchert and Brody.

100. Philosophy of Contemporary Civilization (3) UP fall-spring
Analysis of philosophical issues encountered in public and private decision making. Evaluation of the various techniques used in describing and prescribing alternate plausible ideals and structures for major act-forms and institutions (family, work, education, science, art, recreation, law, politics and religion). Mr. Haynes.

116. Medical Ethics (3) spring
Contemporary moral problems encountered in the practice of medicine examined in the light of ethical theories of the nature and foundation of rights and moral obligations. Abortion, euthanasia, genetic engineering, the nature of informed consent, the distribution of health care, etc. Mr. Hare.

122. Philosophy of Law (3) spring
Selected features of legal institutions, including their nature and functions, sources of law, the constraints of justice and morality, and the logic of judicial reasoning. Special attention is devoted to selected conceptual difficulties in the criminal law, including responsiblity and punishment; to various modes of citizen participation in and control over legal institutions including the jury system and civil disobedience. Mr. Lindgren.

123. Aesthetics (3) fall
Theories, classical and modern, of the nature of beauty and the aesthetic experience. Practical criticism of some works of art, and examination of analogies between arts, and between art and nature. Mr. Hare.

124. (RS 124) Reason and Religious Experience (3) spring
A critical look at some of the fundamental problems of religion: the nature of religious experience and belief, reason and revelation, the existence and nature of God, the problem of evil, and religious truth. Mr. Hare.

126. Philosophical Issues in Feminism (3) spring
Feminist social and political theories and their relevance to such issues as justice, freedom and equality. Proposals for change in the roles of women in western society. Ms. Laslie.

131. Ancient Philosophy (3) fall
Historical study of philosophy in the classical world from the pre-Socratics to Plato, Aristotle, and the Neo-Platonists, as the originators of the western tradition in philosophy and as interacting with the religious, political and scientific life of their times. Mr. Hare.

133. Medieval Philosophy (3) spring 1978
Historical study of philosophy from the fall of the Roman Empire to the Renaissance. Attention to Islamic, Jewish and Christian traditions and their interaction with the scientific and cultural life of the period. Mr. Hare.

135. 17th- and 18th-Century Philosophy (3) spring 1978
Historical study of the major philosophers from the Renaissance to the end of the 18th century; the work of Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, Rousseau, and Kant. Special attention is given to the interaction of political, scientific and philosophical thought during the period. Mr. Lindgren.

137. 19th-Century Philosophy (3) spring 1979
Historical study of the major philosophers of the last century, including Mill, Hegel, Feuerbach, Marx and Nietzsche. Special emphasis will be given to the interaction of the philosophic, social, and political life of the period. Mr. Lindgren.

139. 20th-Century Philosophy (3) spring
Trends in philosophical thought during this century: pragmatism, positivism, lingusistic analysis, existentialism and Marxism. Attention to how recent philosophers have treated such enduring topics as truth and knowledge, values and moral judgment, meaning, the place of the individual in the physical world and in society, and the impact of scientific methodology on all of these. Mr. Melchert.

143. Kierkegaard (1) spring
An introduction to the life and thought of Kierkegaard, the 19th-century Danish forerunner of existentialism, with a brief look at his impact on philosophy, theology, psychology and literature. Mr. Melchert.

144. Karl Marx (1) fall
Introduction to the life and writings of Karl Marx, with special attention to his analyses of alienation, capitalism, history, revolution, and the Communist movement. Mr. Lindgren.

150. (Engl 150) Media and Values (3) fall 1977
How media and values are formed and reformed by their mutual interaction. Combines humanistic criticism with philosophical analysis to study a considerable range of the principal media (the human body, language, film, television, architecture, art) through which human values arise and take their place in the world. Historical, existentialist, phenomenological, and structuralist analyses are stressed. Individual student projects in media-value analysis or manipulation are required. Messrs. Haynes and MacDonald.

For advanced undergraduates and graduates

261. Introduction to Philosophy of Science (3) fall
Analysis of the structure and foundations of scientific knowledge. Topics such as explanation, empirical significance, operationalism, theory and observation, confirmation, and induction are investigated. Ms. Laslie.

264. Meaning (3) spring 1978
Investigation of the problem of how language, a conventional and arbitrary structure of symbols, can be a vehicle of meaning. Theories of meaning, such as the referential, picture, behavioristic, and speech act theories are discussed. Ms. Laslie.

271. Readings in Philosophy (1-3)
A course of readings designed primarily for undergraduate philosophy majors and minors and graduate students in other disciplines. Prerequisite: consent of department chairman.

272. Readings in Philosophy (1-3)
A course of readings designed primarily for undergraduate philosophy majors and minors and graduate students in other disciplines. Prerequisite: consent of department chairman.

301. Philosophy of the Social Sciences (3) spring
An analysis of the social sciences considered as programs for achieving understanding and control of man and society. Study is made of assumptions basic to, and problems incurred in, scientific methodology in general; the implications of these for the various social sciences are stressed. Mr. Haynes.

314. Logical Theory (3) spring 1979
Conceptual foundations and philosophical significance of classical and modern logical theories. Analysis of the syntactic and semantic methods in logic, and their interrelations. Philosophical impact of important technical results, including Goedel's incompleteness theorem. Some discussion of potential future developments and alternative logics. Prerequisite: Phil 14 or consent of department chairman. Mr. Barnes.

315. Contemporary Ethics (3) fall 1978
Recent literature on some ethical theories and metaetrical problems. Subsequent examination of selected substantive issues such as: ecological ethics: strategies and factors in moral education; mythic frameworks of various moralities; relation of ethics to social sciences and to practices in economics, law, religion. Prerequisite: Phil 15 or consent of department chairman. Messrs. Haynes or Melchert.

350. Minds and Bodies (3) fall 1977
Investigation of consciousness in the light of what is known about brains and behavior. The nature and status of sensations, thinking, intentional actions, free choice, and the self are discussed. Mr. Melchert.

391. Advanced Topics in Philosophy (1-3)
Examination of selected topics for philosophy majors and minors and other advanced students. Prerequisite: consent of department chairman.

INFORMATION SCIENCE

Professors. Robert F. Barnes, Ph.D., head, division of information science; Donald J. Hillman, M. Litt., director, Center for Information Science; John J. O'Connor, Ph.D.; Herbert Rubenstein, Ph.D.

Associate professor. Andrew J. Kasarda, Ph.D.

The communication of knowledge and information is essentially a social affair. The very existence of mankind's societies is due to the evolution over the centuries of an entire "information ecology" of elaborately organized and interdependent sets of communications subsystems. Life in the modern world has come to depend especially upon technical means of communication. Yet although the proliferation of this technology has contributed greatly to modern society, it is also largely responsible for the growing imbalances in the interactions of the various subsystems, resulting in the reduced effectiveness of the over-all network.

As a consequence of these imbalances and the resulting problems in the transfer of knowledge and information, certain professional areas have emerged that are concerned with the study of, and the solutions to, these disturbances. New developments in information technology provide new opportunities and methods to cope with these problems. It has become abundantly clear, however, that presently available devices and techniques are in many cases only stopgap measures. Current concern in the field of information science is therefore moving beyond narrow concern with information technology to a much deeper and broader view of the problems themselves.

Even a cursory survey of our society would show that almost no sector of life is untouched by information communication problems and current efforts to apply computers and automation to their solution. There is therefore a critical need today for specialists who can combine expert knowledge of information technology with real understanding of information problems.

For those who desire to devote a substantial proportion of their professional careers, the division of information science offers a major program leading to a bachelor of science in information and communication sciences. The major curriculum emphasizes four core areas—mathematical foundations, behavioral foundations, computer science and technology, and information science and technology. The program requires: a. a 21-credit-hour group of introductory courses; b. twelve credit hours in each of the four core areas; c. an additional eighteen credit hours of approved professional electives; and d. thirty credit hours of distribution courses in social sciences and humanities. The specific requirements are as follows:

introductory courses (21 hours)

IS 11	Computer Programming for the Humanities and Social Sciences (3) or
Engr 1	Introduction to Engineering Problems (3)
Phil 14	Foundations of Logic (3)
Math 21	Analytic Geometry and Calculus I (4)
Math 22	Analytic Geometry and Calculus II (4)
Math 23	Analytic Geometry and Calculus III (4)
Math 105	Computer Programming (3)

mathematical foundations (12 hours)

Math 205	Linear Methods (3)
Math 231	Probability and Statistics (3)
Math 317	Analytical Methods in Information Science (3)
	elective (3)

behavioral foundations (12 hours)

Psych 1	Introduction to Psychology (3)
Psych 51	Elementary Quantitative Psychology (3)
Psych 307	Cognitive Psychology (3)
	elective (3)

computer science and technology (12 hours)

EE 41	Switching Theory (3)
IE 307	Information Systems Engineering (3)
Math 362	Programming Languages (3) or
Math 365	Programming Techniques (3)
	elective (3)

information science and technology (12 hours)

IS 110	Algorithmic Methods (3)
IS 321	Introduction to Information Methodology (3)
IS 330	Low-Cost Personal Retrieval Systems (3)
	elective (3)

approved professional electives
The professional elective courses are chosen by the student, with the approval of the major adviser, to provide a specialized direction to the curriculum. Recommended courses might include:

IS 201	Computers and Language
IS 202	Computers and Society
IS 301	Descriptive Linguistics
IS 320	Information Processing: Human and Machine
IS 361	Automata and Formal Grammars
IS 374	Information Retrieval Theory
IS 379	Introduction to Library Organization
IS 380	Library Automation
Educ 381	Educational Systems and Information Processing
Educ 383	Computer-Assisted Instruction
EE 201	Computer Architecture
EE 311	Compiler Design
EE 315	Principles of Computer Software
IE 206	Operations Research Techniques
IE 309	Data Processing Systems
IE 310	File Structure and Processing
Mgt 270	Conceptual Foundations of Organizational Theory and Behavior
Mgt 316	Organizational Decision Processes
Psych 201	Industrial Psychology
Psych 241	Psychological Principles in Systems Design
SR 131	Science, Technology and Society
SR 171	Computer Applications in Social Relations

Although the College of Arts and Science distribution rules do not apply to bachelor of science degree programs, this major includes a modified distribution requirement. At least thirty hours of courses (among which Psych 1 may be counted, if desired) in the social sciences and humanities are required. Normally, these will be balanced between these areas, and between preliminary and upper levels, in the manner of the bachelor of arts distributional requirements, except that a total of eighteen (rather than twenty hours) are at the upper level.

A minor in information science is also available, consisting of twenty-one hours of approved courses, including IS 11, Computer Programming in the Humanities and Social Sciences. The minor can be structured either as a survey of various areas of computer and information science or as a concentration on a specific topic. An example of the former might consist of IS 11, 110, 202, 321, IE 309, 310 and EE 315. A minor of the latter sort, focussed on human linguistic information processing, might consist of EE 11, IS 201, IS 301, IS 302, IS 320, IS 324, and Psych 307. The specific content of a particular program is chosen in consultation with the student's adviser, based on the student's own needs and goals.

Graduate programs

On the graduate level, both master of science and doctor of philosophy programs are offered.

These aim at providing practitioners in areas of information science and technology with the strong conceptual background necessary to keep pace with rapid changes in the field. Each program provides a base of both theory and application, with emphasis on fundamentals, rather than simply on techniques. Basic to both programs is the concept that research and instruction reinforce each other. Consequently, whenever possible, students are expected to participate in research activities.

The graduate curriculum is based on a bachelor of science degree in an engineering or scientific discipline. Desirable preparation consists of at least twelve hours of mathematics, including nine hours of differential and integral calculus and one course beyond the calculus. In recognition of the flexibility and cross-disciplinary nature of the subject, exception to this requirement may be granted to those students with training in a systematic science. A course in computer programming or programming experience is desirable. Mathematics 105, Computer Programming, is available, without graduate credit, for those without computer background.

Maximum advantage is taken of courses in other departments on the campus. Consequently a student's program is a combination of courses in information science, together with offerings by the departments of electrical engineering, industrial engineering, mathematics, psychology, social relations, and others.

A candidate for the degree of master of science in information science completes at least twenty-four hours of approved course work and submits a thesis or research report. Each student's schedule is chosen in consultation with the head of the division. Three core areas are at the heart of the master of science program: information processing systems; information retrieval theory; and analysis of information. Beyond this basic core, student schedules are planned on an individual basis to fit previous academic experience and career goals. Depending upon the candidate's background and interests, emphasis can be either in theoretical or applied directions.

The division also participates in the University's interdepartmental master of science program in computer science. Requirements for that program can be found on page 50.

A candidate for the doctor of philosophy degree submits a general plan to the department chairman at the beginning of the first year of doctoral studies. This plan must be approved by the candidate's special committee at the time of admission to candidacy.

The doctoral program in information science is based on the candidate's approved plan of original and specialized research. A program of courses and seminars at the 400 level is formulated in the field in which the dissertation will be written.

Information Science Courses

11. Computer Programming for the Humanities and Social Sciences (3) fall
An introduction to computer programming with special emphasis on the requirements of language-oriented applications. Fortran will be taught for basic quantitative manipulations, and Snobol 4 for qualitative purposes. The course stresses the importance of defining and formulating problems via flow charts. No previous knowledge of computer programming is required. Mr. Hillman.

12. Computer Applications in the Humanities and Social Sciences (3) spring
Applications of computers to studies in the humanities and social sciences to obtain greater rigor and sophistication. Both quantitative and qualitative applications are covered, but special attention is given to recent developments of the latter sort, since these applications are often the more significant ones. Prerequisite: IS 11, or its equivalent. Mr. Hillman.

110. (Math 110) Algorithmic Processes (3)
Abstract models of machine processes. Computability and unsolvability, generability, decidability, and acceptability as algorithmic processes. Special topics such as recursive function theory and computational complexity may be covered. Mr. Barnes.

201. Computers and Language (3)
The role of computers in such activities as natural language processing, mechanical translation, speech recognition, and augmentation of human reasoning.

202. Computers and Society (3) spring
A general nontechnical survey of the impact of computers on modern society. Special attention is given to the use of large-scale data banks and retrieval systems, the problems of privacy and file security, and the impact of automation on everyday life.

301. Descriptive Linguistics (3) fall
Techniques for the description of the phonology, morphology, and syntax of natural languages. Special attention to transformational generative grammar. Mr. Rubenstein.

302. (Psych 320) Psycholinguistics (3) spring
Study of the experimental and observational literature on the production and comprehension of utterances and on the acquisition of language. Consideration of performance of the language user. Mr. Rubenstein.

317. (EE 317) Analytical Methods for Information Sciences (3)
Series of topics in discrete mathematics chosen for their applicability to computer science, coding theory and information retrieval. Sets; binary relations; lattices; Boolean algebras and application to logic design; semigroups and relevance to automota; groups and application to coding; fields and relevance to circuits and codes; graphs and application to file searching. Prerequisite: senior standing or consent of department chairman.

320. (Psych 308) Information Processing: Human and Machine (3) alternate years.
Study of the identification, storage, retrieval and use of auditory and visual inputs in decision-making contexts. Human and mechanical information processes, their similarities and differences. Mr. Rubenstein.

321. Introduction to Information Methodology (3)
History, theory and structure of indexing and classification systems for the organization of information; comparative analysis of selected retrieval schemes; experimental methods for developing indexing systems and analyzing subject content.

324. (Psych 324) Life-Span Development of Information Processing Abilities (3) SS
Perception, storage, retrieval, use and com-

Fig. 916. — ISMAEL PACHA, (Khedive of Egypt.)

munication of information as these abilities change from infancy to old age.

330. Low-Cost Personal Retrieval Systems (3) spring
Retrieval systems applicable to personal information collections gathered for study, research, hobby, or other purposes. Experimental study, each student working with his or her personal information collections. Emphasis on systems requiring no mechanical devices. Also some study of computerized systems. Mr. O'Connor.

361. Automata and Formal Grammars (3)
Study of the interaction between recognition devices and generation devices for formal languages. Comparison of automata and formal grammars of differing strengths. Application to questions of computability and decidability. Mr. Barnes.

362. (Math 362) Computer Languages (3)
An examination of a number of high-level computer programming languages, and of the concepts and techniques which are used in the design of the compilers which translate them. Prerequisite: Math 105 or consent of department chairman.

374. Information Retrieval Theory (3)
An introduction to the problems of computerized information storage and retrieval systems. Special attention is given to the logical and mathematical techniques for automatic text-processing, file generation, and inquiry negotiation.

379. Introduction to Library Organization (3) offered as required
An introduction to libraries as information organizations, including their history, function and structure. This course is intended to supply a frame of reference for those students intending to take IS 380, Library Automation; and to provide a background for students interested in broad applications of information science to social and educational needs.

380. Library Automation (3) offered as required
A study of methods and procedures in the application of automated equipment in libraries. Special attention is given to the augmentation of acquisition, cataloging, circulations and reference functions. Prerequisite: IS 379 or consent of department chairman.

390. Special Topics (1-3) offered as required
An opportunity for advanced work through supervised reading and research. Prerequisite: consent of department chairman. May be repeated for credit.

402. (Psych 448) Seminar in Psycholinguistics (3)
Selected topics in psycholinguistics examined in depth and in detail. Prerequisite: IS 302. Mr. Rubenstein.

418. Special Topics in Linguistics (3) offered as required
Selected topics in linguistics not covered in other courses. Mr. Rubenstein.

422. Analysis of Information Systems (3)
The study of the organization of information systems with respect to design criteria, information acquisition and entry, information processing, classification and storage, retrieval and dissemination, feedback control and evaluation; operational requirements such as hardware, software and personnel, and system economics. Mr. Kasarda.

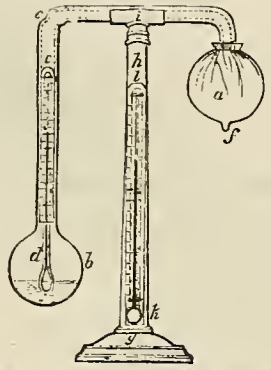

Fig. 1347. — DANIELL'S HYGROMETER.

431. Subject Document Retrieval (3)
Technique and systems for retrieval of documents in response to subject requests. Fundamental ideas, achievements to date, problems and possibilities. Topics covered include request negotiation techniques, document indexing (coordinate, relational, weighted), Boolean and weighted term searching methods, and thesauri and classifications as aids to negotiation, indexing and searching. Mr. O'Connor.

432. ALP-Aided Document Retrieval (3)
Subject document retrieval aided by automatic language processing (ALP). Fundamental ideas, achievements to date, problems and possibilities. Topics covered include computer and man-machine performance of the following functions: subject indexing and classification of documents, abstracting, construction of thesauri and classification of schedules, retrieval by searching natural language text of unindexed documents, and on-line negotiation of retrieval requests. Prerequisite: IS 431 or equivalent. Mr. O'Connor.

433. (EE 403) Design of Operating Systems (3)
Principles of operating systems with emphasis on hardware and software requirements and design methodologies for multiprogramming systems. Global topics include the related areas of process management, resource management, and file systems. Prerequisite: EE 315 or equivalent. Ms. Ota.

442. Evaluation Models (3) offered as required
An investigation of the activities necessary to the development of formal structures for evaluating complex systems. Particular treatment is directed toward the evaluation of large information retrieval systems. Topics covered include establishment of system objectives, recognition and isolation of variables, economic aspects, empirical testing.

450. Information Network Theory (3) offered as required
Applications of graph theory to the modeling, simulation, and design of information networks. Prerequisite: IS 374.

462. Retrieval Languages (3) alternate years
The study of formal indexing and retrieval languages, with special attention to the interaction between syntactic structure and retrieval properties. Examples are drawn from actual and experimental systems to show the effect of syntactic structure upon system capabilities. Mr. Barnes.

466. Topics in the Theory of Automata and Formal Grammars (3) alternate years
Advanced study of automata-theoretic approaches to questions of computability, decidability, acceptability, and generability. May be repeated for credit. Prerequisite: IS 361 or consent of department chairman. Mr. Barnes.

481. Thesis (3)

482. Thesis (3)

492. Special Topics in Information Science (3) offered as required
Selected topics in the information sciences not covered in other courses.

494. Information, Communication and Culture (3) fall
Human communication as a process of exchanging information, as a shaper of the culture, and their mutual interaction. Syntactics, semantics, and pragmatics as theoretical approaches to the study of communication and information.

PHYSICS

Professors. James A. McLennan, Ph.D., chairman; Raymond J. Emrich, Ph.D.; Frank J. Feigl, Ph.D.; Robert T. Folk, Ph.D.; Wyman B. Fowler, Ph.D.; Alvin S. Kanofsky, Ph.D.; Shelden H. Radin, Ph.D.; Wesley R. Smith, Ph.D.; Wesley J. VanSciver, Ph.D.; George D. Watkins, Ph.D., Sherman Fairchild professor of solid state studies.

Associate professors. Brent W. Benson, Ph.D.; Ernest E. Bergmann, Ph.D.; Garold J. Borse, Ph.D.; Yong W. Kim, Ph.D.; Russell A. Shaffer, Ph.D.; Donald B. Wheeler, Jr., Ph.D.

Assistant professor. Jeffrey A. Sands, Ph.D.

Students may major in physics by means of the curriculum of engineering physics in the College of Engineering and Physical Sciences or by means of the physics major in the bachelor of arts curriculum in the College of Arts and Science. The physics contents of the two curricula are similar. The requirements differ mainly in the required distribution courses. A comparison of the two curricula in terms of credit hours in various broad categories is given below.

	engineering physics (credit hours)	B.A. major in physics (credit hours)
Freshman English	6	6
distribution courses (not including mathematics or science)	19	32
required preliminary and major courses	63	63
approved electives	14	8
electives	20 to 26	11
total	122 to 128	120

A student in physics studies the basic laws of mechanics, heat and thermodynamics, electricity and magnetism, optics, relativity, quantum mechanics, and elementary particles. He or she studies applications of the basic theories to the descriptions of bulk matter, including the mechanical, electric, magnetic and thermal properties of solids, liquids, gases, and plasmas, and to the description of the structure of atoms and nuclei. In addition, the student develops the laboratory skills and techniques of the experimental physicist, skills which can be applied in the experimental search for new knowledge or in applications of the known theories.

Because of the fundamental nature of physics and because of the flexibility in the choice of electives, physics students may use the major to prepare for many different careers. The basic program can prepare the student for graduate work in physics or, with appropriate choices of electives, in applied mathematics, in computer science or in allied sciences such as biophysics, molecular biology, astrophysics, geophysics, chemical physics, materials science, meteorology, or physical oceanography.

In addition, the student may choose electives so as to prepare for graduate work in those areas of engineering which have a high science content, such as aeronautical engineering; nuclear engineering, including both fission and fusion devices; electrical engineering, including electronics and solid state devices, electrical discharges and other plasma-related areas; and mechanical engineering and mechanics, including fluids and continuum mechanics. Graduate work in any of these areas can prepare the student for a career in industrial research or development or in university or college teaching and/or research.

The student who plans on employment immediately after the bachelor's degree may choose electives from the many approved and free electives available so as to develop the particular skills needed for a position in a particular area. For example, with the judicious choices of electrical engineering and physics courses in electronics, transistors, and solid state physics, a strong applied background can be developed for employment in solid state electronics. If the student chooses applied mathematics courses and computer courses to supplement the physics course, a strong preparation can be achieved for employment in the many areas which use numerical methods in analysis and development.

Clearly, many other specialties may be developed by the student by appropriate use of electives so that the bachelor degree student can offer an employer the advantages of a broad and fundamental science background combined with a significant concentration in a particular area of science, engineering, or applied mathematics.

Students are advised that admission to graduate school requires a minimum grade average, with a minimum average of B being typical. Also, many graduate schools require a reading knowledge of a modern foreign language.

Physics major in College of Arts and Science

required preliminary courses

Chem 21, 22 Principles of Chemistry (5)
Math 21, 22, 23 Analytical Geometry and Calculus (12)
Phys 11, 12 Introductory Physics I and Lab (5)
Phys 21, 22 Introductory Physics II and Lab (5)

required major courses

Phys 31 Introduction to Quantum Mechanics (3)
Phys 90 Electrical Phenomena (1)
Phys 171 Proseminar (1)
Phys 191 Laboratory Techniques (2)
Phys 212 Electricity and Magnetism I (3)
Phys 213 Electricity and Magnetism II (3)
Phys 215 Particles and Fields I (3)
Phys 216 Particles and Fields II (3)
Phys 254 Optics Laboratory (2)
Phys 340 Thermal Physics (3)
Phys 362 Atomic and Molecular Structure (3)
Math 219, 220 Principles of Analysis (6)
Math 205 Linear Methods (3)
approved electives (8)

The engineering physics curriculum below may serve as a useful guide in designing the sequence for the bachelor of arts physics major.

Engineering Physics curriculum in College of Engineering and Physical Sciences

freshman year (see page 40.)

sophomore year, first semester (15 credits)

Phys 21, 22 Introductory Physics II and Lab (5)
Math 23 Analytical Geometry and Calculus III (4)
General Studies requirement (3)
elective (3)

sophomore year, second semester (17 hours)

Phys 31 Introduction to Quantum Mechanics (3)
Phys 90 Electrical Phenomena (1)
Math 205 Linear Methods (3)
Eco 1 Economics (4)
electives (6)

junior year, first semester (14-17 credits)

Phys 191 Laboratory Techniques (2)
Phys 212 Electricity and Magnetism I (3)
Phys 215 Particles and Fields I (3)
Math 322 Methods of Applied Analysis I (3)
electives (3-6)

junior year, second semester (17 credit hours)

Phys 254 Optics Laboratory (2)
Phys 213 Electricity and Magnetism II (3)
Phys 216 Particles and Fields II (3)
General Studies requirement (3)
electives (6)

senior year, first semester (14-17 credits)

Phys 340 Thermal Physics (3)
Phys 362 Atomic and Molecular Structure (3)
General Studies requirement (3)
electives (5-8)

senior year, second semester (15 credits)

Phys 171 Proseminar (1)
General Studies requirement (3)
electives (11)

The electives must include at least 14 hours of approved technical electives, including two of Physics 363, 364, 365, 366, 367, 368, and 369.

The use of electives. The liberal number of electives provided in both physics curricula provides the student with an opportunity to develop special interests and/or to prepare for graduate work in various allied areas. The student is urged to reflect upon how he or she desires to take advantage of this opportunity. A student contemplating graduate work in physics should strongly consider the many upper-level physics and mathematics courses available, as

well as some of the beginning graduate courses. In addition, she or he should note that some graduate schools require a reading knowledge of a modern foreign language.

Students contemplating using electives to develop a special area of interest should try to plan such a program as soon as possible by consultation with faculty. Since many possibilities exist, it is impractical to list all such programs. Instead, two such programs are listed below to serve as guides for those with interests in those areas and to serve as models for those interested in developing their own programs in other areas.

biophysics

Bio 21	Principles of Biology (3)
Bio 28	Genetics (3)
Biol 35	Microbiology (3)
Biol 320	Cell Physiology (3)
Chem 51	Organic Chemistry (3)
Chem 90 or 194	Physical Chemistry (3)
Chem 371	Elements of Biochemistry (3)
Chem 372	Elements of Biochemistry II (3)
Phys 367	Introduction to Molecular Biophysics (3)
Phys 368	Molecular Biophysics (3)

solid state electronics

Met 91	Elements of Materials Science (3)
EE 20	Introductory Circuit Theory (4)
EE 103	Physical Electronics (3)
EE 105	Electronics Circuits (3)
EE 308	Transistor Theory (3)
EE 351	Microelectronics (3)
Phys 363	Physics of Solids (3)

Undergraduate courses

11. Introductory Physics I (4) fall-spring
Kinematics, frames of reference, laws of motion in Newtonian theory and in special relativity, conservation laws, as applied to the mechanics of mass points; temperature, heat and the laws of thermodynamics; kinetic theory of gases. Two lectures and two recitations per week. Prerequisite: Math 21, 31 or 41, previously or concurrently. Mr. Folk.

12. Introductory Physics Laboratory I (1) fall-spring
A laboratory course to be taken concurrently with Phys 11. Experiments in mechanics, heat, and DC electrical circuits. One three-hour laboratory period per week.

13. General Physics (3) spring
A continuation of Phys 11, primarily for students in the College of Arts and Science and premedical students. Electrostatics, electromagnetism, light, relativity and the universe, atomic physics, nuclear physics and radioactivity, introduction to biophysics. Prerequisites: Phys 11 and Math 21, 31 or 41. Mr. Sands.

14. General Physics Laboratory (1) spring
A laboratory course to be taken concurrently with Phys 13. Prerequisites: Phys 12; Phys 13, preferably concurrently.

21. Introductory Physics II (4) fall-spring
A continuation of Phys 11. Electrostatics and magnetostatics; DC circuits; Maxwell's equations; waves; physical and geometrical optics; introduction to modern physics. Two lectures and two recitations per week. Prerequisites: Phys 11, and Math 23, 32, or 44 previously or concurrently. Mr. Radin.

22. Introductory Physics Laboratory II (1) fall-spring
A laboratory course to be taken concurrently with Phys 21. One three-hour laboratory period per week. Prerequisites: Phys 12; Phys 21, preferably concurrently.

31. Introduction to Quantum Mechanics (3) spring
Experimental basis and historical development of quantum mechanics; the Schrodinger equation; one-dimensional problems; angular momentum and the hydrogen atom; many-electron systems; spectra; selected applications. Three lectures per week. Prerequisites: Phys 13 or 21, and Math 205, previously or concurrently.

32. Modern Physics Laboratory (1)
Laboratory experiments dealing with quantum physics, and illustrative of material covered in Phys 31. One three-hour laboratory period per week. Prerequisite: Phys 21.

42. Physics for Poets (3) spring
The course designed for the nontechnical student. Topics are selected from the 17th and 20th-century revolutions in physics which produced mechanics, relativity and quantum mechanics. These subjects have had profound and far-reaching effects on our society and on our philosophical outlook. High school physics is not assumed. Two recitation periods and one laboratory period per week. No prerequisites. Mr. Kanofsky.

90. Electronics (1) spring
Laboratory studies of DC and AC circuits, solid-state circuit elements, and transistor amplifiers.

171. Physics Proseminar (1) spring
Discussion of current problems in physics. Intended for seniors majoring in the field.

191. Laboratory Techniques (2) fall
Thermometric, calorimetric and vacuum techniques. Advanced electrical measurements. Prerequisites: Phys 21, 22 or 13, 14.

192. Advanced Physics Laboratory (2-3) fall
Laboratory experiments in modern physics designed to introduce students to measuring techniques and phenomena of current interest. Work is of a project nature, and students are placed largely on their own initiative. Intended for seniors majoring in the field.

193. Advanced Physics Laboratory (1-2) spring
Continuation of Phys 192. Intended for seniors majoring in the field.

For advanced undergraduates and graduates

212. Electricity and Magnetism I (3) fall
Electrostatics, magnetostatics, and electromagnetic induction. Prerequisites: Phys 21 or 13; and Math 205 previously or concurrently. Mr. Borse.

213. Electricity and Magnetism II (3) spring
Maxwell's equations; electromagnetic waves with applications to optics. Prerequisite: Phys 212. Mr. Wheeler.

215. Particles and Fields I (3) fall
Aims and fundamental concepts of theoretical physics; foundations of mechanics of mass points, systems of particles, and continuous media; waves; fields; conservation laws. Prerequisites: Math 205, Phys 21, or Phys 13, previously or concurrently. Mr. Smith.

216. Particles and Fields II (3) spring
Generalized coordinates; variational methods in theoretical physics; the Lagrangian and Hamiltonian; basic concepts of the special theory of relativity; survey of the general theory of relativity. Prerequisite: Phys 215. Mr. Emrich.

254. Optics Laboratory (2) spring
Optical instruments and techniques. Examination of phenomena, of measuring procedures, and of light sources and recording devices. Prerequisite: Phys 21 or 13.

281. Basic Physics I (3) summer
A course designed especially for secondary school teachers in the master teacher program. Presupposing a background of two semesters of college mathematics through differential and integral calculus and of two semesters of college physics, the principles of physics are presented with emphasis on their fundamental nature rather than on the applications. Open only to secondary school teachers and those planning to undertake teaching of secondary school physics.

282. Basic Physics II (3) summer
Continuation of Phys 281.

300. Apprentice Teaching in Physics (1-3)

340. Thermal Physics (3) fall
Basic principles of thermodynamics, kinetic theory, and statistical mechanics, with emphasis on physical systems. Prerequisites: Phys 13 or 21, and Math 23, 32 or 44. Mr. Shaffer.

352. Modern Optics (3)
Paraxial optics, wave and vectorial theory of light, coherence and interference, diffraction, crystal optics, and lasers. Prerequisites: Math 23, and Phys 21 or 13. Mr. Bergmann.

362. Atomic and Molecular Structure (3) fall
Structure of atoms and molecules, especially as related to their spectra. Prerequisite: Phys 31 or Chem 191. Mr. VanSciver.

363. Physics of Solids (3) spring
Introduction to the theory of solids with particular reference to the physics of metals Prerequisite: Phys 31 or Met 316 or Chem 191. Mr. Watkins.

364. Nuclear Physics (3) spring
Nuclear models and properties of nuclei. Interaction of nuclear radiation with matter and applications. Radioactive decay; phenomenology and theory. Radiation and particle detectors. Nuclear reactions. High-energy physics. Accelerators. Practical nuclear physics applications. Prerequisites: Phys 31 and Math 205. Mr. Kanofsky.

365. Physics of Fluids (3) fall
Concepts of fluid dynamics; continuum and molecular approaches; waves, shocks and nozzle flows; nature of turbulence; experimental methods of study. Prerequisites: Phys 212 or EE 231, and Phys 340 or ME 104 or equivalent, previously or concurrently. Mr. Emrich.

366. Ocean Physics (3)
Underwater sound and optics, thermodynamics of the oceans, other topics in physical oceanography such as currents, tides and waves. Prerequisites: Math 205 and Phys 21 or 13. Mr. VanSciver.

367. Introduction to Molecular Biophysics (3) fall
A development of the molecular basis of life in terms of physical principles. Topics include molecular biology of the gene, energy flow as an organizing factor in biology, intra- and intermolecular interactions, and the determination of macro-molecular structure and function. Techniques discussed include light scattering and X-ray diffraction. Prerequisite: Phys 13 or 21. Messrs. Benson and Sands.

368. Molecular Biophysics (3) spring
Further topics in molecular biophysics including the problems of membrane structure and function, the action of radiation on cells and the structure of cell water. Techniques discussed include ultracentrifugation, electron spin resonance, nuclear magnetic resonance, ultraviolet and infrared spectroscopy. Prerequisites: Phys 367 or consent of department chairman. Messrs. Sands and Benson.

369. Introduction to Quantum Mechanics (3) fall
Principles of quantum mechanics; applications to atoms and molecules. Prerequisites: Phys 31, 216, Math 205. Mr. Bergmann.

372. Special Topics in Physics (1-3)
Special topics in physics not sufficiently covered in the general courses. Lecture and recitations or conferences.

For graduates

The department of physics has concentrated its research activities within several fields of physics, with the consequence that a number of projects are available in each area. Current departmental research activities include the following:

Solid-state physics (experimental). Optical properties of insulators, defects in insulators, electron paramagnetic resonance, properties of thin films.

Solid-state physics (theoretical). Energy band calculations in insulators, excited states and lifetimes of defects, properties of impurities in insulators.

Molecular biophysics. Magnetic resonance studies of nucleic acid derivatives. Molecular assembly processes of viruses. Membrane biophysics.

Ocean physics Optical absorption and luminescence of organic and inorganic materials in sea and ice.

Plasma spectroscopy. Collisional and collisionless phenomena of very dense plasmas.

Nuclear theory. The few nucleon problem, nuclear structure theory.

Physics of fluids. Transition from laminar to turbulent flow in boundary layers, microscopic fluctuations in a flow, shock-induced reactions in gases, energy transfers, relaxation times, lifetimes, and phase transitions at liquid-vapor interfaces.

Fig. 1105. — GALLERY IN EXETER CATHEDRAL, (ENGLAND.)
(Beginning of the 14th century.)

Statistical physics. Kinetic theory, transport in plasmas with strong magnetic fields, statistical basis of hydrodynamics, nonlinear processes.

Elementary particles (experimental). Cosmic ray studies; production of jets (at Fermilab); high-energy particule channeling (at Fermilab); Kaoninduced hypernuclei (at AGS); particle-nuclei reactions (at ZGS).

Elementary particles (theoretical). Properties of leptons, the vector boson, methods for handling unrenormalized field theories, electromagnetic interactions.

Laser physics. Construction of gas lasers and studies of their characteristics; use of gas lasers in determination of oscillator strength and atomic parameters; mode structure; holography.

Candidates for advanced degrees normally will have completed, before beginning their graduate studies, the requirements for a baccalaureate degree with a major in physics, including advanced mathematics beyond differential and integral calculus. Students lacking the equivalent of this preparation will make up deficiencies in addition to taking the specified work for the degree sought.

Doctoral candidates may be required by their thesis committee to demonstrate a reading knowledge of one language, usually chosen from French, German or Russian. Some graduate work in mathematics is usually required; and certain advanced courses in other fields, notably mechanics, metallurgy and materials science, electrical engineering, and chemistry, may be included in a graduate program. Further details regarding the special requirements for degrees in physics may be obtained on application to the department chairman.

At least eight semester hours of general college physics using calculus are required for admission to all 200- and 300-level courses. Additional prerequisites for individual courses are noted in the course descriptions. Admission to 400-level courses generally is predicated on satisfactory completion of corresponding courses in the 200 and 300 groups or their equivalent.

Special departmental facilities for teaching and research include six shock tubes with advanced instrumentation; optical and cryogenic equipment for solid-state studies; magnetic resonance equipment. Facilities of the Material Research Center are available, including crystal preparation equipment, electron microscope facilities, and light-scattering equipment. Extensive use is made for both teaching and research of the Computing Center, which includes a CDC 6400 computer. The Sherman Fairchild Laboratory for Solid State Studies, opened in 1976, is the hub for solid-state activity on campus. It houses a 3 MeV Van de Graaff accelerator and other research facilities and equipment.

Faculty from the physics department participate in the interdisciplinary master of science and doctor of philosophy programs in molecular biology. See page 51.

Graduate courses

420. Theoretical Physics (3) fall
This and the three courses, Phys 421, 422 and 423, cover the classical theory of particles and fields. Phys 420 includes the variational methods of classical mechanics, methods of Hamilton and Lagrange, canonical transformations, Hamilton-Jacobi theory. Mr. Smith.

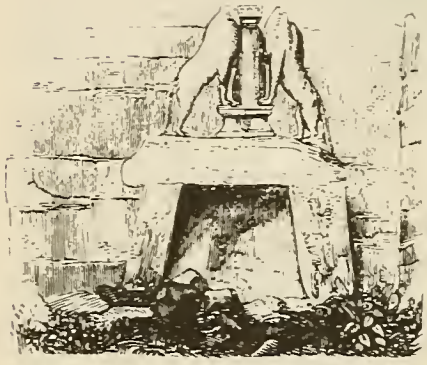

Fig. 751.—CYCLOPEAN DOOR OF THE LIONS. (*Mycenæ.*)

421. Theoretical Physics (3) spring
Theory of elasticity; fluid dynamics; tensor analysis; electrostatics and magnetostatics. Prerequisite: Phys 420. Mr. Kim.

422. Advanced Theoretical Physics (3) fall
Electromagnetic radiation; dynamics of charged particles; multipole fields; special theory of relativity and covariant formulation of electrodynamics. Prerequisite: Phys 421. Mr. VanSciver.

423. Advanced Theoretical Physics (3) spring, alternate years.
Electrodynamics in anisotropic media; physical optics; theory of diffraction and application to holography; applications of electrodynamics in various fields of physics. Prerequisite: Phys 422. Mr. Bergmann.

424. Quantum Mechanics (3) spring
General principles of quantum theory; approximation methods; spectra; symmetry laws; theory of scattering. Prerequisite: Phys 369 or equivalent. Mr. Borse.

425. Quantum Mechanics (3) fall, alternate years.
A continuation of Phys 424. Relativistic quantum theory of the electron; theory of radiation. Mr. Shaffer.

428. Methods of Mathematical Physics (3) fall
The equations of theoretical physics and the methods of their solution. Mr. Folk.

429. Methods of Mathematical Physics (3) spring
Continuation of Phys 428. Mr. Folk.

431. Theory of Solids (3) fall
Advanced topics in the theory of the electronic structure of solids. Many-electron theory. Theory of transport phenomena. Magnetic properties, optical properties. Superconductivity. Point imperfections. Desirable preparation: Phys 363 and Phys 424. Mr. Fowler.

434. Solids and Radiation (3) alternate years.
Phenomena in solids resulting from interaction with electromagnetic radiation or charged particles. Current theories of energy adsorption, transport and emission. Prerequisite: Phys 363 or equivalent.

442. Statistical Mechanics (3) fall
General principles of statistical mechanics with application to thermodynamics and the equilibrium properties of matter. Prerequisites: Phys 340 and 369. Mr. Kim.

443. Statistical Mechanics (3) alternate years
A continuation of Phys 442. Applications of kinetic theory and statistical mechanics to nonequilibrium processes; nonequilibrium thermodynamics. Prerequisite: Phys 442. Mr. McLennan.

447. (Biol 447, Chem 447). Experimental Molecular Biology (3)
A survey of current research in molecular biology.

451. Topics in Biophysics (1-3) alternate years
An intensive study of recent advances in a selected area of biophysics. May be repeated for credit when a different topic is offered. Prerequisite: Phys 368. Messrs. Benson and Sands.

462. Theories of Elementary Particle Interactions (3) alternate years
Relativistic quantum theory with applications to the strong, electromagnetic and weak interactions of elementary particles. Prerequisite: Phys 425. Mr. Shaffer.

465. Nuclear and Elementary Particle Physics (3) spring
Nuclear structure and phenomena; interactions among elementary particles and methods of studying them. Mr. Kanofsky.

467. Nuclear Theory (3) spring, alternate years.
Theory of low-energy nuclear phenomena within the framework of nonrelativistic quantum mechanics. Mr. Borse.

471. (Mech 411) Continuum Mechanics (1-3) fall
An introduction to the nonlinear continuum theories of the mechanics of solids and fluids. This includes an discussion of the mechanical and thermodynamic bases of the subject, as well as the use of invariance principles in formulating constitutive equations. Applications of the nonlinear theories to specific problems are given. Mr. Rivlin.

472. Special Topics in Physics (1-3)
Selected topics not sufficiently covered in the more general courses. May be repeated for credit.

474. Seminar in Modern Physics (3)
Discussion of important advances in experimental physics.

475. Seminar in Modern Physics (3)
Discussion of important advances in theoretical physics.

491. Research (3)
Research problems in experimental or theoretical physics.

492. Research (3)
Continuation of Phys 491. May be repeated for credit.

PSYCHOLOGY

Professors. Arthur L. Brody, Ph.D.; Joseph M. Brozek, Ph.D.

Associate professors. William Newman, Ph.D.; Martin L. Richter, Ph.D., chairman; George K. Shortess, Ph.D.

Assistant professors. Leslie Horst, Ph.D.; Edwin J. Kay, Ph.D.; Roger C. Loeb, Ph.D.; Lawrence M. Paul, Ph.D.

Adjunct professors. Herbert Rubenstein, Ph.D.; John B. Siegfried, Ph.D.; Mervin P. Smolinsky, Ph.D.

There are two major programs available in psychology. The bachelor of arts program is in the liberal arts tradition with the student free to include courses from a wide variety of academic disciplines and with maximum freedom of course selection in psychology.

With a judicious selection of courses, students can prepare themselves for graduate study in

clinical psychology, developmental psychology, social psychology, or personality, or for careers in areas for which psychology is a desirable and relevant major, e.g. law, social work, nursing, or special education.

The bachelor of science program stresses preparation in mathematics and science with an emphasis on experimental psychology. This program is intended for the student who plans on graduate study in experimental psychology, medicine or dentistry.

The bachelor of arts major

required major courses

Psychology: thirty semester hours with at least fifteen semester hours in courses numbered 200 or higher. No more than six semester hours of experimental courses (Psych 121, 162 and 300) can be counted toward the major course requirement. Psych 300 can be counted toward the major requirement no more than once. Note: this is a new requirement effective for the class of 1980; the old requirement still in effect for students already enrolled is for twenty-four semester hours with at least twelve semester hours in courses numbered 100 or higher.

additional required courses

College of Arts and Science distribution requirements. Elective courses to bring semester hour total to 120.

recommended courses

Strongly recommended courses for students preparing for graduate study in clinical psychology, developmental psychology, social psychology, or personality.

Psych 1	Introduction to Psychology (3)
Psych 109	Statistical Analysis (3)
Psych 111	General Experimental Psychology (4)
Psych 161	Independent Research (1-3)

plus a selection from the following recommended courses:

Psych 107	Child Psychology (3)
Psych 162	Psychological Field Work (1-3)
Psych 205	Abnormal Psychology (3)
Psych 311	History of Modern Psychology (3)
Psych 353	Personality Theory (3)
Psych 354	Personality Assessment (4)
Psych 371	Learning (3)
Psych 373	Sensory Processes (3)
Psych 375	Physiological Psychology (3)
SR 21	Social Psychology (3) or
SR 121	Social Psychology of Small Groups (3)
Math 41	BMSS Calculus (3)
Biol 21	Principles of Biology (3) or
Biol 28	Genetics (3)

The bachelor of science major

required major courses

Psych 1	Introduction to Psychology (3)
Psych 109	Statistical Analysis (3)
Psych 111	General Experimental Psychology (4)
Psych 151	Elementary Quantitative Psychology
Psych 311	History of Modern Psychology (3)
Psych 371, 372	Learning and Laboratory (4)
Psych 373, 374	Sensory Processes and Laboratory (4)
Psych 375, 376	Physiological Psychology and Laboratory (4)

Note: the following additional major requirement is effective for the Class of 1980.

plus three of the following social science psychology courses:

Psych 107	Child Psychology (3)
Psych 162	Psychological Field Work (3 credits only)
Psych 205	Abnormal Psychology (3)
Psych 331	Humanistic Psychology (3)
Psych 353	Personality Theory (3)
Psych 354	Personality Assessment (4)

additional required courses

Engl 1	Composition and Literature (3)
Engl 2, 10, 14, or 16	Composition and Literature (3)
Math 21, 22, 23	Analytic Geometry and Calculus (12) or
Math 31, 32	Calculus (8) or
Math 41, 42, 43, 44	BMSS Calculus, Probability, Linear Algebra, Calculus (12)
Biol 21, 22	Principles of Biology and Laboratory (4)
Chem 21, 22	Introductory Chemical Principles and Laboratory (5)
Phys 11, 12	Introductory Physics I and Laboratory (5)
Phil	selection of a philosophy of science course (3)

plus twelve semester hours selected from the following:

Math 105	Computer Programming (3)
Math 205	Linear Methods (3)
Math 219	Principles of Analysis I (3)
Math 220	Principles of Analysis II (3)
Math 231	Statistical Inference (3)
Math 309	Theory of Probability (3)
Math 310	Probability and its Applications (3)
Math 334	Mathematical Statistics (3)
Math 362	Computer Languages (3)
Biol 28	Genetics (3)
Biol 306	Ecology (3)
Biol (Geol) 317	Evolution (3)
Biol 320	Physiology (3)
Biol 324	Animal Behavior (3)
Chem 51	Organic Chemistry (3)
Chem 52	Organic Chemistry (3)
Chem (Biol) 371	Elements of Biochemistry (3)
Chem (Biol) 372	Advanced Biochemistry (3)
Phys 21, 22	Introductory Physics II and Laboratory (5)
IS 11	Computer Programming for the Humanities and Social Sciences (3)
IS 12	Computer Applications in the Humanities and Social Sciences (3)
IS 201	Computers and Language (3)
IS 202	Computers and Society (3)
IS 302 (Psych 320)	Psycholinguistics (3)
IS 320 (Psych 308)	Information Processing: Human and Machine (3)
IS 324	Life-span Development of Information Processing Abilities (3)
IS 361	Theory of Formal Grammars (3)

or other courses with the approval of the department chairman. (It is recommended that these twelve semester hours be concentrated in an area, e.g., mathematics, probability and statistics, biology, biochemistry, computer science.)

plus sufficient electives to meet the 120 semester-hour minimum requirement for graduation. Of these electives, at least thirty semester hours must be broadly distributed in the humanities and the social sciences outside of psychology.

Note: the requirement that social science courses be selected from outside of psychology is effective beginning with the Class of 1980.

The psychology minor

The psychology minor consists of fifteen credit hours in psychology chosen by the student together with a faculty adviser from the psychology department.

Undergraduate courses

Note: As with other course listings, the code initials on the first line of each entry indicate the course's distribution-level rating. The next entry, NS or SS, applies only to psychology courses and refers to Natural Science or Social Science distribution requirements. Some listings also state the semester in which the course is customarily offered.

1. Introduction to Psychology (3) P NS SS fall-spring
Psychology as a science of behavior. Natural science aspects such as learning, sensation-perception, and physiological bases; and social science aspects such as human development, intelligence, and personality. Methodologies appropriate to these areas, and related societal problems.

75. (Phil 75) Behavior Control and Human Values (3) P SS fall
Philosophical examination of operant conditioning techniques for controlling behavior. Value problems related to autonomy of individual choice, responsibility, rationality, freedom and dignity, and punishment. To what end shall behavior be controlled, and who will control the controllers? Prerequisite: an introductory course in either psychology or philosophy, or consent of department chairman. Messrs. Brody and Melchert.

107. Child Psychology (3) SS fall
Theories and data concerning the development of the human organism from fetus to adolescent. Emphasis is placed on the methods and techniques employed. Prerequisite: Psych 1. Mr. Loeb.

108. Adolescent and Adult Psychology (3) SS alternate years
Descriptions and explanations of the developmental process from adolescence to death. Stresses of adolescence, changes during adulthood, and ways of dealing with old age and death. Prerequisite: Psych 1. Mr. Loeb.

109. Statistical Analysis (3) NS fall, spring
An integrated presentation of the basic methods of evaluating data in psychological research. Messrs. Kay and Paul.

111. General Experimental Psychology (4) NS spring
A survey of basic data and research methods in experimental psychology with emphasis on the

areas of learning and psychophysics; laboratory exercises and an independent research project. Prerequisite: Psych 1. Messrs. Kay and Richter.

121. Encountering Self and Others (3) SS fall-spring
An experientially oriented course to facilitate personal growth and develop a fuller awareness of personal functioning and interpersonal perception and communication. Prerequisite: consent of department chairman. Ms. Horst and Mr. Newman. Pass-fail grading.

131. Psychology of Women (3) SS fall
Biological, cross-cultural, sociological and psychological perspectives on women, with reference to personal experience where appropriate. Prerequisite: Psych 1 or an introductory social relations course, and consent of department chairman. Ms. Horst.

142. Human Memory (3) NS spring
Previous and current models of human memory. Attention, encoding, organization, imagery, and devices for memory improvement. Prerequisite: Psych 1. Mr. Paul.

151. Elementary Quantitative Psychology (3) NS fall
Quantitative analysis of behavior, including perception, choice and preference, conditioning, memory, and problem-solving. Messrs. Kay and Richter.

160. Independent Study (1-3) NS SS fall-spring
Readings on topics selected in consultation with a staff member. Prerequisites: Psych 1 and consent of department chairman. May be repeated for credit.

161. Independent Research (1-3) NS SS fall-spring
Research in areas selected in consultation with a staff member. Prerequisites: Psych 1, 111, and consent of department chairman. May be repeated for credit.

162. Psychological Field Work (1-3) SS fall-spring
Work-study practice including supervised experience in one of several local agencies. Development of familiarity with the operations of the agency and working with individual patients or students. Prerequisites: Psych 1 and consent of department chairman. May be repeated for credit. Mr. Loeb.

201. Industrial Psychology (3) SS spring
Psychological concepts and methods applied to business and industrial settings. Personnel selection, placement and training, leadership, work motivation, and job satisfaction; and consumer behavior. Prerequisite: Psych 1. Mr. Paul.

205. Abnormal Psychology (3) SS fall
The patterns, causes and treatment of various forms of abnormal behavior. Supplemented by sessions at Allentown State Hospital. Prerequisites: Psych 1, and three additional hours of psychology or consent of department chairman. Mr. Loeb.

211. Insanity: Psychological and Legal Views (3) SS spring
Problems with the concept of insanity, its use and misuse; commitment procedures, incompetency, and the insanity defense; the right to treatment and to refuse treatment; the right to be different and the dangers of a therapeutic society. Mr. Brody.

221. Psychophysiology of Motivation (3) NS spring
Neurological foundations of thirst, hunger, temperature regulation, reproduction, and maternal behavior. Prerequisite: Psych 1. Mr. Shortess.

241. Psychological Principles in Systems Design (3) SS fall
Application of experimental psychology to facilitate the interaction between people and machines, and between tasks and environments. Human capacities, limitations, and requirements; traditional engineering psychology considerations; man as part of a social and environmental system. Prerequisite: Psych 1. Mr. Paul.

300. Apprentice Teaching in Psychology (1-3) NS SS fall-spring

303. Mathematical Models in Psychology (3) NS fall
The application of mathematics in psychology, including models for psychophysics, learning acquisition curves, discrimination learning, concept formation and probability learning. Prerequisite: Psych 111. Mr. Kay

307. Cognitive Psychology (3) NS fall
Processing of information by human beings. Topics include contemporary theories of perception, attention, memory, and decision-making. Prerequisite: Psych 1. Mr. Paul.

308. (IS 320) Information Processing: Human and Machine (3) NS alternate years
Study of the identification, storage, retrieval, and use of auditory and visual inputs in decision-making contexts. Human and mechanical information processes, their similarilties and differences. Mr. Rubenstein.

311. History of Modern Psychology (3) NS spring
History of psychology, with emphasis on the emergence and growth of scientific study of behavior. Includes the reading of primary sources and the autobiographies of the major contributors to the field. Prerequisite: Psych 1. Mr. Brozek.

320. (IS 302) Psycholinguistics (3) SS spring
For course description, see IS 302, page 175. Mr. Rubenstein.

324. (IS 324). Life-Span Development of Information Processing Abilities (3) SS fall
Perception, storage, retrieval, use, and communication of information as these abilities change from infancy to old age. Mr. Rubenstein.

331. Humanistic Psychology (3) SS fall
The literature of and metaphors underlying the humanistic point of view in psychology. These "models of man" will be contrasted with models underlying other modes of psychological inquiry. Prerequisite: Psych 1. Mr. Newman.

342. Construction of Psychological Reality (3) SS spring
The relationship between cognitive structures and world view, particularly the influence of language on perception, and the cultural context of learning and thought. Contributions of B. L. Whorf, Michael Polanyi, John Lilly, Michael Cole, and others. Prerequisite: as least six credit hours in psychology. Mr. Newman.

353. Personality Theory (3) SS fall
Review and critique of theories of personality and their associated systems of psychotherapy. Includes developing knowledge and theory about people as well as the theoretical concepts themselves. Prerequisite: Psych 1. Ms. Horst.

354. Personality Assessment (4) SS spring
Methods of describing and measuring personality. Observational techniques, interviews, self-report inventories, intelligence tests, and projective tests. Prerequisite: Psych 1. and consent of department chairman. Mr. Loeb.

370. Experimental Child Psychology (3) SS spring
Evaluation and employment of observational and laboratory methods used in the scientific study of children. Prerequisite: Psych 107 and consent of department chairman. Mr. Loeb.

371. Learning (3) NS spring
Principles of learning with emphasis on reinforcement, discrimination, motivation, verbal learning and memory. Critical evaluation of classical and contemporary theories of learning. Prerequisite: Psych 1. Messrs. Brody and Richter.

372. Learning Laboratory (1) NS spring
Experimentation on the learning process utilizing animal and human subjects. Prerequisites: Psych 111; Psych 371, previously or concurrently. Messrs. Brody and Richter.

373. Sensory Processes (3) NS spring
Receptor processes of vision, audition, touch, taste and smell are considered with particular emphasis on problems of sensory intensity, sensory discrimination functions and perceptual processes. Quantitative methods are stressed. Prerequisite: Psych 1. Mr. Shortess.

374. Sensory Processes Laboratory (1) NS spring
Laboratory exercise applying quantitative methods to the study of sensory processes. Prerequisites: Psych 111, Psych 373, previously or concurrently. Mr. Shortess.

375. Physiological Psychology (3) NS fall
The physiological basis of bahavior, both human and animal. Particular emphasis is placed on the neural mechanisms involved. Prerequisites: Psych 1; eight semester hours of physics, chemistry or biology. Mr. Shortess.

376. Physiological Psychology Laboratory (1) NS fall
A survey of techniques in physiological psychology. Prerequisite: Psych 375 previously or concurrently. Mr. Shortess.

381. Psychological Testing (3)
Psychological tests of intelligence, achievement, and personality with emphasis on applications in educational situations. Principles of measurement and test construction stressed. Prerequisite: Psych 1, or consent of department chairman. Open only to graduate students in the School of Education. Mr. Brody.

383. Personality (3)
Review and analysis of psychological concepts and data relevant to the development and functioning of personality. Comparison and

Fig. 1546—HYGEIA.

critical examination of the major historical schools of personality theory. Prerequisite: Psych 1 or consent of department chairman. Open only to graduate students in the School of Education. Mr. Smolinsky.

For graduates

Although the psychology department does continue to have a Ph.D. program and a number of graduate students working toward that degree, the emphasis in the graduate program has shifted toward the doctor of arts (DA) degree - a doctoral degree for teaching. Accordingly no new doctor of philosophy candidates are being accepted for admission through fall, 1977.

Most job opportunities for people with doctoral degrees in psychology involve at least some teaching, and yet, the traditional Ph.D. model places its primary emphasis on the development of research skills. There seems to be an implicit assumption that teaching skills are either not important or not learnable. Lehigh does not accept either of these assumptions and therefore offers a doctoral program emphasizing the teaching of psychology, while continuing to include training in research and experimental skills. The DA program presents psychology as an experimental science and stresses the ability to design and critically analyze research. However, our goal is to prepare people for careers in college teaching at two- and four-year colleges rather than in institutions emphasizing research.

The DA program differs in a number of ways from the traditional Ph.D. program. It encourages greater breadth of coverage within the various areas of psychology including courses dealing with issues and techniques for college teachers, requires extensive teaching experience including a supervised internship, has training in interpersonal awareness, and substitutes a doctoral project involving problems of teaching and learning for the traditional research dissertation. In addition the program requires an empirical master's thesis, a comprehensive general examination, and a minor concentration of courses from outside of the psychology department. Training in the DA program also stresses the acquisition of skills applicable to teaching and research such as course preparation, report writing, and audio-visual aids (videotape, programming and electromechanical research techniques).

The beginning student is required to take during the first year: Analysis and Design of Experiments, a one-year course in theoretical and applied statistics and research methodology; DA Seminar, discussions including first and second year students on various topics of concern to teachers; Projects in Research, an apprentice-style research and communication experience; two content courses; and one of the following two courses: College Teaching of Psychology or Interpersonal Awareness.

In subsequent years the student is required to complete a core of content courses within psychology and further courses and experiences in teaching, as well as the examination and project requirements described above. A general examination is administered to all candidates for a doctoral degree (recommended no later than the end of the third year), and there is an oral final examination focusing on the DA project. At the end of every semester each graduate student is evaluated by the faculty and informed of how well he or she is progressing in the graduate program. This evaluation is based on performance in examinations in Analysis and Design of Experiments and content courses, progress in research, and performances in teaching-oriented courses and teaching experiences.

Lehigh's psychology department is small enough to provide a personalized approach to graduate study (student-faculty ratio approximately 1:1). Since the DA program is in a continuing state of development, it is hoped that graduate students will play an active role with the faculty in shaping and improving the DA program during their stay at Lehigh.

The current faculty describes their research and scholarly interests as: Arthur Brody, learning and learning theory, psychological and legal views of insanity, behavior modification; Josef Brozek, history of psychology, Soviet and East European psychology, impact of malnutrition on behavior; Leslie Horst, sex differences, self-esteem, personal change, interaction in groups; Edwin J. Kay, mathematical models, learning and memory, psychopharmacology; Roger C. Loeb, child psychology, family interaction, normal and abnormal personality development; William Newman, group process in humanistic psychology, state of consciousness and perceived quality of life, higher education, student drug use; Lawrence Paul, human cognitive psychology, memory and information processing, and engineering (systems) psychology; Martin L. Richter, discrimination learning and cognition, mathematical psychology and statistics; George K. Shortess, physiological processes underlying sensory processes, vision and sensory interaction in relation to aesthetic experience.

Applications for admission and financial aid may be obtained from the department of psychology. Completed application forms plus transcripts, letters of recommendation, and a report of scores on the Graduate Record Examination aptitude tests and advanced test in psychology should be returned to the office of admission not later than February 1 of the year of admission.

Normally, new students are accepted for entrance into the program only for the fall semester. Financial support is available in the form of teaching and research assistantships, fellowships and scholarships. There are special fellowships for minority students. While a good undergraduate background in psychology is desirable, promising students with majors other than psychology are encouraged to apply.

409. D.A. Seminar (1) fall-spring
One-hour meeting per week of first-and second-year graduate students to discuss topics of concern to teachers. May be repeated for credit.

411. Interpersonal Awareness (3)
Designed to improve awareness of personal functioning and to enhance interpersonal perception and communication. Application to problems of teaching and learning. Prerequisite: consent of department chairman. May be repeated for credit. Mr. Newman.

421. Analysis and Design of Experiments (3)
First of a two-semester sequence covering a variety of issues in theoretical and applied statistics with emphasis on inferential statistics and analysis of variance. Messrs. Kay and Paul.

422. Analysis and Design of Experiments (3) spring
Continuation of Psych 421. Prerequisite: Psych 421. Messrs. Kay and Paul.

434. Special Topics in Personality (3)
Selected topics in personality theory and research, including but not limited to personal change, ego psychology, and psychology of women. May be repeated for credit. Ms. Horst.

438. Special Topics in the History of Psychology (3)
Contemporary historiography of psychology; methods of historiography, with special reference to quantitative and archival research; roots of experimental psychology in experimental psychology; history of Russian and Soviet psychology; history of research on visual functions. May be repeated for credit. Mr. Brozek.

441. Communicating Psychological Concepts (3)
How to organize facts and ideas into broader meaningful units that are readily communicable. Includes media aids and the structured experience as a communication aid. Prerequisite: consent of department chairman. Mr. Newman.

448. (IS 402) Seminar in Psycholinguistics (3)
Selected topics in psycholinguistics examined in depth and in detail. Prerequisite: IS 302. Mr. Rubenstein.

450. Special Topics in Mathematical Models and Statistics (3)
Selected topics in the application of mathematics to psychological theory and the application of statistics to psychological research. May be repeated for credit. Messrs. Brody, Kay and Richter.

453. Advanced Topics in Learning (3)
An intensive study with emphasis on current research of discrimination learning, avoidance learning, concept learning, problem solving, or verbal learning. May be repeated for credit. Messrs. Brody and Richter.

460. Special Study (1-3) fall-spring
Study of some special topic not covered in the regular course offerings. May be repeated for credit.

461. Research (1-3) fall-spring
Original research not connected with master's or doctoral thesis. May be repeated for credit.

463. College Teaching of Psychology (3) fall-spring
Consideration of problems in the preparation and presentation of college courses in psychology; ancillary problems associated with the profession of psychology; practice in teaching. May be repeated for credit.

464. Projects in Research (3) spring
One or more research projects carried out in apprenticeship with a faculty member; course concludes with written and oral reports based on these projects.

465. Teaching Internship (3-6) fall-spring
The preparation, teaching and grading of one or two undergraduate courses with appropriate supervision by Lehigh faculty. Observation and evaluation of the intern via classroom visits and videotapes. May be repeated for credit.

471. Applied Psychology Internship (1-6) fall-spring
Supervised, independent field work experience in e.g., industry, a medical setting, or a mental health setting. May be repeated for up to six hours credit.

472. Special topics in Physiological Psychology (3)
Selected topics from sensory psychophysiology, drive, short-term memory mechanisms, bioelectrics, etc. May be repeated for credit. Mr. Shortess.

474. Special Topics in Developmental Psychology (3)
Topics selected from such areas as socialization and the parent-child interaction, personality disorders in childhood, moral development and cognitive development. May be repeated for credit. Mr. Loeb.

476. Special Topics in Cognition (3)
Selected topics in human information processing including perception, attention, memory, thinking, and decision making. Mr. Paul.

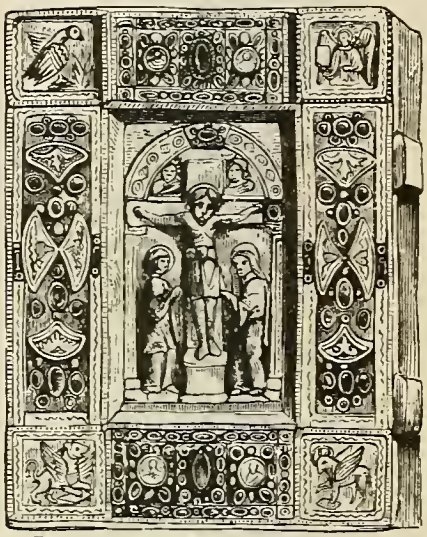

Fig. 387. — COVER OF MISSAL OF THE 15TH CENTURY. Enamel, ivory, and precious stones. (Imperial Library, Paris.)

RELIGION STUDIES

Professor. A. Roy Eckardt, Ph.D., chairman.
Associate professor. Hubert L. Flesher, M.A.
Assistant professors. Alice L. Eckardt, M.A.; Park McGinty, Ph.D.

As an intrinsic dimension of culture, religion exerts abiding influence upon human thought, affect, and behavior. This fact furnishes the rationale for the study of religion at Lehigh. The department of religion studies is committed to forms of intellectuality identical with those pursued in other humanistic and scientific disciplines. The primary purpose in the department is to foster and complete the individual student's liberal education. Secondarily, the scholarly analysis of religion comprises one foundation for a mature personal and social faith.

Courses afford a comprehensive understanding of the world's major religious traditions and their contributions to human culture. The curriculum extends through the methodology of and introduction to religion study, the history of religions in East and West, biblical studies, the place of personal and social religion within a secular culture, influential theological movements and issues, and the relating of religion and theology to contemporary moral, social, and aesthetic questions.

The study of religion is inherently interdisciplinary. Students who concentrate in religion studies are enabled to emphasize one or more of the above subfields. The major is preparatory to a number of professions and vocations, including the law, medicine, government service, teaching, journalism and business.

Major in religion studies

Normally, RS 11 is the foundational course. A minimum of ten additional courses in the department are selected in consultation with the chairman. Some students may desire to pursue a double major of religion studies with another of the humanities, or with one of the social or natural sciences.

In light of the interdisciplinary character of study in religion, students are encouraged to consult with the chairman respecting selected collateral work in other fields of the humanities and in the social sciences. Those who plan to pursue graduate work are advised to study a foreign language or foreign languages appropriate to their area of concentration.

Minor in religion studies. Normally, a minor consists of RS 11 plus a minimum of four other courses, chosen in consultation with the chairman.

Recommended freshman distribution courses. The normal possiblities include RS 11, 17 and 18. With the consent of their advisors, freshmen may enroll in RS courses at the 100 level.

Recommended upperclass distribution courses. Any religion studies course at the 100 level or above is acceptable.

Note on Biblical languages. With sufficient student demand, the department will offer for credit instruction in Biblical Hebrew and in the Greek New Testament.

Courses of Study

11. Religions of Man (3) P fall-spring
The world's major religious traditions: Judaism, Christianity, Islam, Hinduism, Buddhism, and Chinese and Japanese religions. Mr. McGinty.

17. Issues of Faith (3) P fall
The problem of achieving a viable personal faith. Study of such persistent issues as: Is God real? Is there hope? Does faith conflict with reason and science? How may we decide between conflicting faith-claims? What is man? What is his destiny? Why do people suffer? Mr. Eckardt.

18. Religion and Modern Society (3) P spring
The relating of religious principles and theological understanding to a comprehension and resolution of pressing moral and social issues of today: sex, marriage and intermarriage; revolution, the law and civil rights; racism and religious prejudice; biomedical ethics; and problems in ecology. Mr. Eckardt.

111. Biblical Studies I (3) fall
Theological examination of a major portion of the Hebrew scriptures, with emphasis upon literary, historical and critical problems. The Near Eastern context of Hebraic religious development; the Exodus tradition and the Patriarchal Period; the conquest of the land; the development and dissolution of the monarchy; beginnings of the prophetic movement. Mr. Flesher.

112. Biblical Studies II (3) spring
Theological examination of the later Hebrew scriptures and the Intertestamental Period. The prophetic movement; the Exile and return; the Temple and its culture; the Wisdom Literature; the rise of apocalyptic thought; the Maccabees and the Roman conquest; the Dead Sea Scrolls; Palestine and Judaism in Jesus' time; the sectarian movement of John the Baptist and Jesus as represented in the New Testament. Mr. Flesher.

113. Biblical Studies III (3) fall
Study of early Christianity, with emphasis upon New Testament and early Apostolic writings. The Synoptic Gospels; the Fourth Gospel; Paul's writing; the later Epistles; the Apostolic Fathers; the development of Gnosticism; parallel Hellenistic religions; newly discovered secret gospels from the 2nd century. Mr. Flesher.

121. Religions of India and China (3) fall
The rise, development, and teachings of Hinduism and Chinese religious traditions. Emphasis on beliefs and forms of practice, especially meditational techniques. Mr. McGinty.

122. Tribal Religions (3) spring
Religious worlds of nonliterate peoples, with emphasis on selected African and North American traditions. Religious thought and behavior (myths, cosmologies, rituals, initiation, witchcraft and shamanism) that bear upon man's attempt to relate to ultimate reality and to his socio-cultural and natural environment. Mr. McGinty.

123. Judaism and Christianity (3) fall
The rise, development and teachings of the Jewish and Christian traditions. Emphasis upon beliefs and practices, especially as these affect society and culture. Mr. McGinty.

124. (Phil 124) Reason and Religious Experience (3) spring
A critical look, from a philosophical perspective, at some fundamental problems of religion: the nature of religious experience and belief, reason and revelation, the existence and nature of God, the problem of evil, and religious truth. Mr. Hare.

126. Buddhism (3) spring
Rise and development of the Buddhist religion, its view of reality, and its meditational practices. The biography of the Buddha; Theravada, early Mahayana, Tibetan, and Zen schools; interactions with society and culture, especially art and politics. Mr. McGinty.

151. The Jewish-Christian Encounter (3) fall
Analysis of relations between the Jewish community and the Christian church in history and the present. Stress upon moral issues such as antisemitism and upon doctrinal similarities and differences between Judaism and Christianity. Religious and sociopolitical aspects of the reestablishment of the State of Israel. Mr. Eckardt.

153. (Hist 153) Religion and the American Experience (3) fall
The historical development of major religious groups in this country from colonial times to the present. Their place in social and political life, and the impact of the national experience upon them. Emphasis on religious freedom and pluralism, and the church-state relationship. Mrs. Eckardt.

154. (Hist 154) The Holocaust: History and Meaning (3) spring
The Nazi Holocaust in its historical, political and religious setting. Emphasis upon the moral, cultural and theological issues raised by the Holocaust. Mrs. Eckardt.

161. Current Protestant Thought (3) fall
Major 20th-century movements in Protestant theology, understood as responses to the problems of modern times. Study of such theologians as Karl Barth, Dietrich Bonhoeffer, Rudolf Bultmann, James H. Cone, Reinhold Niebuhr, Richard Niebuhr and Ian T. Ramsey. Emphases include demythologizing, "the death of God," liberalism versus conservatism, new trends in hermeneutics, and the ecumenical movement. Mr. Flesher.

162. Current Catholic and Jewish Thought (3) spring
Major 20th-century movements in Roman Catholic and Jewish theology, understood as responses to the problems of modern times. Study of such theologians as Martin Buber, Abraham Heschel, Hans Kung, Jacques Maritain and Karl Rahner. Current issues such as Vatican Council II and its aftermath, and "radical Judaism." Mr. Flesher.

171. Religion and the Arts (3) fall-spring
Examination of religious themes in such areas as literature, film, and painting, with shifting content from term to term. Alternate fields of study include world literature, modern prose works, the contemporary American novel, and science fiction and fantasy.

202. Technology-Science-Theology (3) spring
The understanding and assessment of our technological and scientific culture through study of such contemporary thinkers as Ian Barbour, Harvey Cox, Jacques Ellul, Pierre Teilhard de Chardin and Paul Tillich. Mr. Eckardt.

214. (IR 214) International Affairs and Political Theology (3) spring
From the standpoint of theological understandings of man's nature and of human collective life, an assessment of the nation-state, of the role of power in international affairs, of national sovereignty and internationalism, and of war, pacifism and alternative methods of conflict-resolution. Mr. Eckardt.

242. Methods and Issues (3) spring
Anthropological, sociological, psychological and phenomenological interpretations—especially their models of man and reality—applied to understanding religious phenomena. Mr. McGinty.

271. Special Topics (3) fall-spring
Intensive study in areas appropriate to the interests and needs of students and staff.

300. Apprentice Teaching in Religon Studies (1-3) fall-spring

SOCIAL RELATIONS

Professors. Roy C. Herrenkohl, Jr., Ph.D.; Robert C. Williamson, Ph.D.; Linton C. Freeman; Ph.D., Lucy G. Moses distinguished professor.

Associate professors. Robert E. Rosenwein, Ph.D., chairman; James R. McIntosh, Ph.D.

Assistant professors. Barbara B. Frankel, Ph.D.; Barbara K. Kopytoff, Ph.D.

Course of study

There are three disciplines combined in the department of social relations: social psychology, sociology and anthropology. These disciplines have as their central and shared concern the understanding of human behavior in relationships, or more generally, theory and research about people in social settings.

Students who sample broadly in these course offerings can learn about the dynamics of small groups, prejudice, communication, attitude change, deviance, social networks, conflict and conflict resolution, major social institutions, the relationship of the physical environment to behavior, cultures and culture differences, and the like. Students who major in social relations can expect to be exposed to the special content of these three disciplines and the methodological skills with which they are associated.

Graduates of this department, especially with some advanced training, can expect to find job opportunities in both public and private areas, particularly in programs dealing with community development, population analysis, public opinion research, medical systems research, juvenile delinquency and education. Although demand in teaching areas will lessen, it will be strongest in public and private programs dealing with the development of human resources. Combined with a major or minor in government or psychology, social relations provides a good background for students interested in the law, the ministry, or the helping professions.

Special programs and opportunities

Students interested in social work may enroll in the Social Work Education Program, a joint undertaking of the Lehigh Valley Association of Independent Colleges. This program prepares students for employment as professional social workers and for graduate study in social work.

Although not required, most students in this program major in social relations and take additional courses and fieldwork in other valley colleges. Students who complete the social work program are certified by the association. This certification entitles the graduate to take the Caseworker I Civil Service Test, and makes him or her eligible for advanced placement in many graduate schools of social work, leading to the master of social work degree. For further information about this program, contact Dr. Robert C. Williamson.

Major requirements

SR 211, 212 (6)
at least one of the following:
SR 386, 391, 393, 395 (3)
SR 399 (3)
four at the 300 level (12)
total required hours 24

requirements for the minor: fifteen hours including SR 211-212.

Undergraduate courses

5. The Social System (3) P
Analysis of social organization emphasizing structure, function, stability and change.

9. The Anthropological Enterprise (3) P
Comparing and contrasting different social and cultural versions of the world. What anthropologists do and how they think about what they do.

21. Social Psychology (3) P
Theories, Methods of investigation, and results of research in social psychology with emphasis on psychological processes in social behavior, social attitudes, group behavior, and social interaction. Not offered to students who have had SR 7.

41. Human Sexuality (3) P
Analysis of the socialization of sex roles and the life cycle, premarital and marital sex behavior, human reproduction and its control. Some attention to deviant sex roles.

51. Visual Sociology (3) UP
Introduction to the use of the still camera as a tool for creating important social and sociological images. Development of the photo essay as a sociological reporting technique. Mr. Freeman.

52. Social Sciences and the Arts (3) UP
Contributions of the social sciences to the understanding of aesthetic processes and products; focus on one or more media and/or a specific class of aesthetic objects. Messrs. Freeman and Rosenwein.

65. Contemporary Social Problems (3) UP
Studies of major problems facing contemporary society. May be repeated for credit with permission of department chairman. Mr. McIntosh.

75. Minority Groups (3) UP
Study of racial and ethnic intergroup relations.

85. Sociology of Politics (3) UP
Organization and development of political action structures. Analysis of ideology, stratification, leadership, and patterns of participation.

111. Social Psychology of Education (3)
An examination of the manner in which teaching and learning are influenced by interpersonal, group and institutional factors. The influence of family dynamics, peer-group pressures, teacher-expectations and social status on the individual's educational adjustment.

121. Social Psychology of Small Groups (3)
Study of interpersonal behavior in groups. Survey of relevant theories and empirical research. Mr. Rosenwein.

131. Science, Technology and Society (3)
Relationships of science and technology to social life. May be repeated for credit with permission of department chairman.

141. Social Deviance (3)
Analyses of deviant social systems, supporting factors maintaining them, and societal responses to deviant roles and collectivities. Mr. McIntosh.

151. Utopias and Alternative Communities (3)
The search for new forms of community placed in historical and theoretical perspective. Mrs. Frankel.

161. Sociology of Occupations (3)
Analysis of occupational choice, recruitment, training and socialization. Attention to the questions of the occupational professional continuum, the work setting, alienation, the relation of careers to various social organizations, the life cycle and demographic trends. Mr. Williamson.

171. Computer Applications in Social Relations (3)
Computer applications in the social and behavioral sciences. Students learn a simple computer language and write programs in areas of personal interest.

211. Integrated Study of Social Relations (3) fall
Theory and methodology in analyses of social relations. Use of contemporary journals and other materials providing an introduction to requisite skills in anthropology, sociology and social psychology.

212. Integrated Study of Social Relations (3) spring
Continuation of SR 211. Prerequisite: SR 211.

307. Attitudes and Social Influence (3)
An examination of the concept of attitude in social psychology and the determinants of attitude change. Attention to problems and issues in persuasive communication, propaganda, brainwashing, conformity, and other social processes. Prerequisite: SR 211 or 212 or consent of department chairman.

308. Seminar in Social Psychology (3)
Intensive consideration of selected topics in current theory and research in social psychology. The subject matter varies from semester to semester, and includes such topics as the social psychology of education, the applications of perception and learning theory to social psychological problems, the social psychology of science, and the social environment of communication. Prerequisite: SR 211 or 212 or consent of department chairman. May be repeated for credit with permission of department chairman.

309. Socialization Through the Life Span (3)
An examination of interpersonal influences on human development from birth through aging. Consideration of social influences on the development of the ability to communicate, the learning of social roles, the development of socially oriented motivation, personality dynamics, and the impact of societal pressures on the processes of maturing and aging. Prerequisite: SR 211 or 212, or consent of department chairman.

311. Social Ecology (3) fall
Relationships between people and artificial environment. Architectural design, social organization, personal awareness of environment, and human needs for privacy, personal territory, or interpersonal space. Mr. Herrenkohl.

312. Interpersonal Behavior in Small Groups (3)
Intensive consideration of theoretical and methodological issues in the analysis of the development of small groups. Prerequisite: SR 211-212 or consent of department chairman. Mr. Rosenwein.

320. Urban Ethnology (3)
Urban subcultures of several continents and their relations to "mainstream" cultures; consideration of various methods appropriate to their scientific investigation. Mrs. Frankel.

325. (Hist 325) American Social History, 1607-1877 (3) fall
Social change from early agrarian communities to beginnings of industrialism, emphasizing socio-economic class, family structure, and treatment of women and minority groups.

326. (Hist 326) American Social History Since 1877 (3) spring
Changing role of women, minority groups, and the family during the industrial era. Development of the modern class structure and the impact of the welfare state.

336. Symbolic Anthropology (3)
Study of how human experience is mediated through the use of symbols; religious, linguistic, and artistic symbol systems in cross-cultural perspective. Prerequisite: SR 211-212 or consent of department chairman. Mrs. Frankel.

337. Anthropological Theory (3)
Major social-scientific syntheses used by anthropologists in the field of anthropology and how these do or do not qualify as "theories." Prerequisite: SR 211-212 or consent of department chairman. Mrs. Frankel.

339. Seminar in Anthropology (3)
Intensive consideration of selected topics in contemporary or past research in cultural anthropology. The subject matter varies from semester to semester. May be repeated for credit. Prerequisite: SR 211-212 or consent of department chairman.

361. Social Conflict (3)
An examination of theory and research on interpersonal, inter-group and international conflict and conflict resolution. Consideration of the characteristics of individuals and of the dynamics of groups which predispose them to conflict or enable them to avoid or resolve conflict.

364. The Family (3) spring
A sociological study of man's basic institution. Includes an analysis of historical backgrounds, interactions within the family, relation to other groups and institutions, problems of family disorganization, legal aspects of marriage and divorce, family adjustment, the family in a changing society. Mr. Williamson.

367. Change and Conflict in Latin America (3) fall
Introduction to the changing societies of Latin America including contrasts between urban and rural subcultures. Analysis of ethnic groupings and social institutions, especially family, school and church. Mr. Williamson.

368. The Urban Community (3) spring
A study of urban communities in the world and the United States. A history of the city, ecological and demographic patterns and growth, institutional organization, status systems, suburban development, resources and problems, future development and planning. Prerequisite: six credit hours in social relations or consent of department chairman. Mr. McIntosh.

369. Social Disorganization (3)
Social disorganization in contemporary society, with emphasis on the concepts of anomie and alienation. Evaluation of various theories of social disorganization. Prerequisite: six credit hours in social relations or consent of department chairman.

370. Juvenile Delinquency (3)
The development of delinquent behavior within its social context; an analysis of delinquent gangs and subcultures and the variable patterns of antisocial activity; and evaluation of institutional controls and treatment of the problem.

371. Special Topics in Social Relations (1-3)
An opportunity for advanced work through supervised reading and research. Prerequisite: consent of department chairman.

372. Special Topics in Social Relations (1-3)
Continuation of SR 371.

373. Seminar in Sociology (3)
Intensive consideration of selected topics in contemporary theory or research in sociology. The subject matter varies from semester to semester. Prerequisite: SR 211 or 212, or consent of department chairman. May be repeated for credit.

374. Social Stratification (3)
Examination of concepts of stratification, such as social class, and of theories using these concepts. Consideration also of research findings which indicate the significance of stratification for society. Prerequisite: SR 211 or 212, or consent of department chairman.

385. Social Structure (3)
The theory of social structure considered as a basic key to the understanding of social phenomena, with attention to such concepts as interaction, position, role and role-set, status, institutionalization, equilibrium, norm, and culture. Selected propositions concerning structural relationships and processes will be examined. Prerequisite: SR 211 or 212, or consent of department chairman.

386. Methods in Network Analysis (3) alternate years
Study of form and process of interpersonal aspects of human behavior. Stress on ways of examining patterns of links occurring between persons and several whole networks of social relations. Prerequisites: SR 211-212 and 385, or consent of department chairman. Mr. Freeman.

391. Evaluation Research (3) alternate years
Application of social research methods to evaluation of the effectiveness of social programs. Consideration of measurement,

Fig. 914. — STATUES OF MEMNON.
(In the plain of Thebes.)

research design, criteria of effectiveness, and decision-making. Prerequisite: SR 211-212 or consent of department chairman. Mr. Herrenkohl.

393. Experimental Social Psychology (3) alternate years
Methods and techniques for studying social psychological phenomena in the laboratory and other controlled settings. Prerequisite: SR 211-212 or consent of department chairman. Mr. Rosenwein.

395. Methods in Observation (3) alternate years
Naturalistic and participant observation in uncontrolled field settings. Prerequisite: SR 211-212, or consent of department chairman. Mrs. Frankel.

397-398. Independent Research (3-4)
Students will conduct research under faculty supervision. Prerequisite: consent of department chairman.

399. Senior Project (3)
Independent work fulfilling major requirement. Prerequisites: SR 211-212, and consent of the department chairman.

For graduates

411. Advanced Research Methods (3) fall
A basic course given in research theory and methods. Consideration given the nature of theory, hypotheses testing, the definition of variables and methods of measurement. Mr. Herrenkohl.

412. Practicum in Research Methods (3) spring
Laboratory in the design and execution of research. Emphasis on the design of measurement instruments, the application of statistical techniques, and the analysis and interpretation of data. The student pursues an independent research project and writes a research report based on it. Prerequisite: SR 411.

423. Social Psychology (3)
An examination of theory and research in social psychology. The objective of the course is to consider major topics and issues in relation to current research. Mr. Rosenwein.

432. Culture Patterns and Personality (3)
The psychological implications of cultural variation, including the analysis of national character. Mrs. Frankel.

434. Advanced Social Psychology (3)
Intensive consideration of selected topics in social psychology. The subject matter varies from semester to semester on topics such as socialization, social attitudes, person perception, small group processes and communication. Messrs. Herrenkohl and Rosenwein.

464. Seminar on the Family (3)
Societal functions of marriage and the family and the relation of the institution to the social structure and demographic variables. Particular emphasis on the treatment of family disorganization. Mr. Williamson.

465. Organizational Behavior (3)
Theory and research concerning the development and functioning of organizations. Structure, goals, authority and power, communication, role conflict in large organizations. Cross-institutional comparisons of industrial research, governmental, medical and academic organizations.

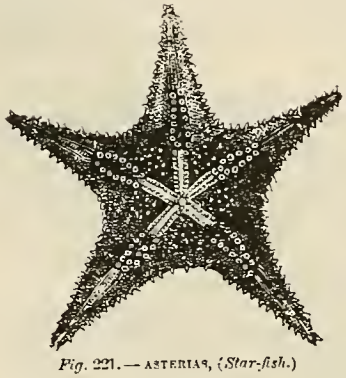

Fig. 221. — ASTERIAS, (*Star-fish.*)

467. Latin American Social Structure (3)
Analysis of given Latin American societies with special attention to economic and political structures. Individual projects. Mr. Williamson.

468. Advanced Urban Sociology (3)
Selected problems in urban research, urban and community planning and redevelopment. Relation of the city and the region to economic development and govenment functions. Mr. McIntosh.

470. Contemporary Sociological Theory (3) fall
An examination of current developments in theoretical sociology. Functional theory and conflict theory as reflected in Parsons, Merton, Coser and Dahrendorf and others. A critique of current theoretical schools.

471. Special Topics (1-3)
Intensive study in an area of social relations which is appropriate to the interests and needs of staff and students.

472. Special Topics (1-3)
Continuation of SR 471.

PRIZES AND AWARDS

Student prizes and awards are announced at commencement exercises on Founder's Day, the second Sunday in October, and on University Day in May or June. A description of prizes and awards follows.

Alumni Prizes. Funds are provided by the Alumni Association for the annual award of four prizes of $25 each. Two prizes are awarded to the highest-ranking juniors in the College of Engineering and Physical Sciences, one to the highest-ranking junior in the College of Arts and Science, and one to the highest-ranking junior in the College of Business and Economics.

Medal of the Philadelphia Chapter, American Institute of Chemists. This medal is awarded to the academically highest-ranking senior majoring in chemistry or chemical engineering.

American Society for Testing Materials Student Membership Prize. The ASTM awards each year four student memberships to students who in their junior year have demonstrated interest and meritorious work in the engineering courses which are related to the ASTM.

Bethlehem Fabricators Award. This tuition award is made to the junior who has shown the most improvement in academic achievement over previous years.

The Robert W. Blake Memorial Prize. This prize is awarded annually at Founder's Day exercises to a freshman, upon completion of one year of studies in the College of Arts and Science, who is recommended by the college faculty as the most outstanding in high scholastic achievement and in promise of worthy leadership.

The John B. Carson Prize. An annual prize of $50 was established by Mrs. Helen Carson Turner, of Philadelphia, in memory of her father, John B. Carson, whose son, James D. Carson, was a graduate of the civil engineering curriculum in 1876. It is awarded to the senior in civil engineering who shows the most marked excellence in professional courses.

The William H. Chandler Prizes in Chemistry. Four annual prizes of $25 each, one in each class, for excellence in the chemistry and chemical engineering curricula were established by Mrs. Mary E. Chandler, of Bethlehem, widow of Dr. William H. Chandler, who was professor of chemistry at Lehigh from 1871 until his death in 1906.

The N. I. Stotz and D. E. Rickert Choral Cup. The choral cup provided by Norman I. Stotz, Jr., '53, and Donald E. Rickert, '53, is awarded to the outstanding senior participating in the choral organizations of the music department.

Class of 1904 Scholarship Award. To an outstanding member of the junior class on the basis of character, scholarship, qualifications indicating promise of future leadership, and extracurricular activities.

The R. K. Burr and J. D. Kirkpatrick Concert Cup. The concert cup provided by Richard K. Burr, '53, and J. Donald Kirkpatrick, '55, is awarded to the outstanding senior(s) participating in the instrumental organizations of the music department.

The Cornelius Prize. The Cornelius Prize of $25, established by William A. Cornelius, M.S., '89, and endowed by a bequest by his widow, Mrs. Eleanor R. W. Cornelius, is awarded annually to the senior student in mechanical engineering who is judged to have profited most by opportunities at Lehigh. The award is based 70 percent on scholarship, 20 percent on attainment in general culture, and 10 percent on development in personality. To be eligible for the award, a student's scholastic standing must be in the top quarter of the class in the College of Engineering and Physical Sciences.

The Philip Francis du Pont Memorial Prize in Electrical Engineering. The Philip F. du Pont Memorial Prize Fund was established in 1929 by L. S. Horner, E.E. '98. The annual income of this fund is awarded each year in the way of prizes, two-thirds to the highest-ranking senior and one-third to the second-highest-ranking senior in electrical engineering.

Jonathan B. Elkus Freshman Music Cup. This is awarded each year to a full-time freshman on the basis of membership in Marching and Concert Band, over-all music ability, and demonstrated leadership and exceptional psyche.

Fraternity Alumni Advisory Council Scholarship Improvement Award. This trophy is awarded to the fraternity chapter whose scholastic average for the year is most improved over the average for the previous year.

The Gold-Hansen Trophy. Provided by Stephen R. Gold and Robert A. Hansen, both members of the class of 1960, the trophy is awarded to a student of at least four semesters standing with the Lehigh University Band who has shown outstanding merit in other ways than musical or marching performance.

Malcolm J. Gordon, Jr., Physics Prize. An annual award of $40 is made to the highest-ranking sophomore majoring in physics with some extracurricular activity.

The Bill Hardy Memorial Prize. An annual award of $100 is given by Mr. and Mrs. C. Edson Hardy in memory of their son to the junior who most nearly reflects the qualities that typified Bill Hardy, who was outstanding in many activities, academic and otherwise.

Haskins and Sells Foundation Award. An annual award of $500 is awarded to that accounting student in the College of Business and Economics or the College of Arts and Science who after three years has demonstrated excellence in scholarship, professional potential, extracurricular activities, and moral character.

Donnel Foster Hewett Award. This is awarded to the senior in geology or geological sciences who has demonstrated the greatest potential for a professional career in the earth sciences.

The Harold J. Horn Prize. The heirs of Harold J. Horn, E.E. '98, established a fund, the income of which is used in the award of a first and second prize of $40 and $20 respectively for the two highest-ranking juniors in electrical engineering.

Kappa Alpha Glee Club Senior Cup. To a senior for outstanding service to the Lehigh University Glee Club.

The Andrew Wilson Knecht III Memorial Award. This award is made each year to the member of the mechanical engineering class graduating in May or June who has exhibited the greatest potential for applying technical training to practical application. The award is an engraved designed medallion.

The McClain Award for Meritorious Painting. This award, consisting of a trophy and a $15 purchase prize, and provided by Austin V. McClain, is presented to the student of painting in the fine arts department studio classes who completes the most meritorious painting during the academic year.

The McClain Progress Award. This award, consisting of a trophy and a $15 purchase prize, and provided by Austin V. McClain, is presented to that student whose progress in painting in the fine arts department studio classes during the year is most marked.

Merck Index Award. A copy of the Merck Index is awarded by Merck and Co., Inc., to a senior in chemistry who is an outstanding student, who has been active in student society affairs and who has promise of a successful career in chemistry in the judgment of the faculty of the chemistry department.

The Elizabeth Major Nevius Award. Established by Walter I. Nevius, E.E., '12, "in living memory of his wife, who profoundly admired young men of diligence, intelligence, aggressiveness and sterling character," the award of $500 is made annually to that senior enrolled in any five-year combination curriculum leading to two baccalaureate degrees who, upon completion of his or her first four years at Lehigh University and upon graduation with his or her class, shall be adjudged the most outstanding of the seniors completing work for their first baccalaureate degree and continuing to a second baccalaureate degree at Lehigh University, judged upon the basis of leadership, citizenship, and scholarship.

Pat Pazzetti Award. In honor of Vincent Joseph "Pat" Pazzetti, Jr., class of 1915, to a Lehigh football player of outstanding ability.

The Pennsylvania Institute of Certified Public Accountants Prize. This plaque goes to the senior in the College of Business and Economics majoring in accounting who is outstanding in academic achievement and leadership.

Phi Sigma Kappa Scholarship Cup. This scholarship cup, awarded to the fraternity in the Interfraternity Council having the highest scholastic average for the preceding year, becomes the permanent property of the fraternity winning it for three successive years. The cup was provided by an alumnus of the Nu Chapter of Phi Sigma Kappa in 1923. Cups are provided by the local chapter.

The Allen S. Quier Prize in Metallurgy. An annual prize of $15 has been provided by the daughters of the late Allen S. Quier in memory of their father, to be awarded to the senior who is adjudged by the staff of the metallurgy and materials science department to have made the most progress in that curriculum. While high scholastic standing is a requisite, the prize is awarded on the basis of progressive achievement in scholastic work, rather than an average rating.

Bosey Reiter Leadership Cup. This award is given to the student whose leadership contributes primarily to the best interests of the university. Leadership is defined chiefly as moral character and combines intellectual ability and common sense. High scholarship and athletic achievements are included as cases of leadership, but neither is necessary or sufficient alone.

Robert Ridgeway Senior Prize. This prize is awarded to the engineering senior with the highest cumulative average.

Col. Edward W. Rosenbaum Award. The award, in honor of Robert Rosenbaum, class of 1917, is awarded each year to recognize the outstanding senior aerospace studies student.

The Senior Band Plaque. The plaque was established by the seniors on the executive committee of the Lehigh University Band to honor a member or members of the senior class of the band who have given outstanding performances in both marching and concert seasons for four years and who have not served in a major administrative capacity in the band.

T. Edgar Shields Band Cup. This is awarded annually to the student who has made the greatest musical contribution to the Band.

T. Edgar Shields Glee Club Cup. This is awarded annually to the student who has made the greatest musical contribution to the Glee Club.

Sigma Xi Undergraduate Research Award. An award of $50 and associate membership in the society is made to an undergraduate student by the chapter executive committee from departmental nominations. The basis of the award is research potential and demonstrated achievement in research.

Spillman and Farmer Architectural Award. An architectural book and $15 is awarded to the student(s) creating the outstanding architectural or environmental design in the architecture classes of the fine arts department.

Alan H. Stenning Award. This is awarded each year to a senior mechanical engineering or mechanics student for excellence in an undergraduate engineering project.

Bradley Stoughton Student Award. This award is given to an outstanding senior in the metallurgy and materials science department. It consists of a certificate and $25.

Thornburg Mathematics Prize. This prize is made possible through a bequest by the late W. P. Tunstall, '03, in honor of the late Professor Charles L. Thornburg. The prize, consisting of a credit slip for $40 to purchase books in the field of mathematics or allied disciplines at the Bookstore, is awarded to the senior with the most outstanding record in an advanced course in mathematics.

Trustees' Scholarship Cup. The trustees have provided this cup which is awarded for one year to the living group having the highest scholarship average for the preceding year. The cup becomes the permanent property of any living group winning it for three successive years.

University Service Award. This award is given annually to the senior who has been adjudged to have contributed most during his or her career at Lehigh, to promote student body unity, campus cooperation for worthy objectives, and loyalty to the alma mater. It is expected that the student selected shall be of sound character and satisfactory scholarship.

John R. Wagner Award. This is awarded each year to the junior student in mechanical engineering whose scholastic record is the highest in his or her class in the freshman and sophomore years and whose character and life purposes are deemed deserving and worthy.

Wall Street Journal Award. This is awarded each year to a senior finance major primarily on the basis of scholarship.

William Whigham, Jr., Memorial Prize. This is awarded annually to the top-ranking freshman in engineering, based on accumulative average of the first two semesters.

The Elisha P. Wilbur Prizes. A fund was established by the late E. P. Wilbur, trustee from 1872 until 1910, for distribution in prizes as the faculty might determine. The income from this fund is used to provide two awards, as follows:

Wilbur Mathematics Prizes. A first and second prize of $50 and $25 respectively to be awarded annually to the two highest-ranking freshman engineers in mathematics, as recommended by the department of mathematics.

Wilbur Scholarship Prize. This prize of $200 is awarded annually to the sophomore with the best semester average for the sophomore year.

The Williams Prize in Creative Writing. A prize of $100 is awarded annually to the author of a meritorious short story, play, or poem submitted by a Lehigh undergraduate.

The Williams Prize in Dramatics. A prize of $100 is awarded annually to a Lehigh undergraduate whose interpretation of a role in a production of the Mustard and Cheese dramatics club is judged the most outstanding.

The Williams Prizes in English. The late Professor Edward H. Williams, Jr., class of 1875, established prizes for excellence in English composition and public speaking. The prizes are awarded by the faculty on the recommendation of the department of English, as follows:

Freshman Composition Prizes. A first prize of $100, a second prize of $75, and a third prize of $50 are awarded for the three best compositions submitted by freshmen as required work in their English courses.

Sophomore Composition Prizes. A first prize of $100, a second prize of $75, and a third prize of $50 are awarded for the three best compositions submitted by sophomores as required work in their English courses.

Junior Composition Prizes. A first prize of $100, a second prize of $75, and a third prize of $50 are awarded for the three best essays submitted by juniors as part of the required work in their courses in English.

The Williams Prizes in Extempore Speaking. A first prize of $100 and a second prize of $50 are awarded annually to freshmen of regular standing who excel in a contest in extempore speaking. A first prize of $100, a second prize of $75, and a third prize of $50 are awarded annually to the winners in a contest in extempore speaking for sophomores, juniors and seniors. Winners of first prizes are not eligible to compete in subsequent years.

The Williams Prize in Interpretive Reporting. A prize of $100 is awarded annually to a Lehigh undergraduate for meritorious reporting, published or unpublished, intended to interpret the meaning of events or developments which are significant in the life of the university.

The Williams Prizes in Intramural Debating. Sums totaling $300 are awarded annually as prizes in intramural debating. Students engaged in this activity are organized under the direction of the department of English into teams which compete in a series of debates. The sum of $200 is divided equally between the two members of the first-place team and the sum of $100 is divided equally between the two members of the second-place team. Winners of first-place prizes are not eligible to compete in subsequent years.

The Williams Prize in Varsity Debating. A prize of $100 is awarded annually to a Lehigh undergraduate whose performance in intercollegiate debating is judged the most outstanding.

The Williams Senior Prizes. These prizes are awarded by the faculty on the recommendation of the committee on Williams Prizes.

1. First prizes of $200, second prizes of $100, and third prizes of $50 are awarded annually in each of the five fields of economics, English, philosophy, psychology, and history and government for dissertations submitted by regular members of the senior class on or before April 15.

2. The committee on Williams Prizes publishes, before the close of the academic year, a list of recommended subjects for dissertations; but a senior may submit a dissertation upon any other subject in the respective field if the subject has received the approval of the committee.

3. Each senior entering the competition shall submit to the committee his or her choice of subject and plan or work by November 15.

4. The awards are made by the faculty upon recommendation of the committee, but no award is made if in any case a dissertation does not meet the standards of merit established by the committee. This standard includes such points as excellence in thought, plan, development, argument, and composition.

The Theodore B. Wood Prize. A prize of $50 is awarded under the terms of the will of the late Theodore Wood to the mechanical engineering student who has made the greatest scholastic improvement during the first two years of the college course.

Prizes awarded by student organizations. These prizes include the following:

Alpha Epsilon Delta Award. Alpha Epsilon Delta places the name of the premedical biology freshman with the highest cumulative average on a plaque in the department of biology.

Alpha Kappa Psi Key. The Alpha Sigma Chapter of Alpha Kappa Psi, a professional

Fig. 918. — AVENUE IN THE GREAT HALL OF COLUMNS AT KARNAC, (Thebes.)

fraternity in commerce, awards annually the Alpha Kappa Psi scholarship key to the senior pursuing a degree in the College of Business and Economics who has attained the highest scholastic average for three years of collegiate work at Lehigh.

The Alpha Pi Mu Prize. The Alpha Pi Mu honorary fraternity in industrial engineering awards each year an industrial engineers' handbook to a high-ranking sophomore with demonstrated interest in the industrial engineering curriculum.

American Chemical Society Award. The Lehigh Valley Section of the American Chemical Society awards a membership in the society and a subscription to a journal of this society to the highest-ranking junior in chemistry or chemical engineering.

American Society of Civil Engineers Prize. The Lehigh Valley Section of the American Society of Civil Engineers offers a prize of a junior membership in the society to the outstanding senior in civil engineering holding membership in the student chapter.

American Society of Mechanical Engineers Associate Membership Prize. The Anthracite-Lehigh Valley Section of the American Society of Mechanical Engineers awards a prize of the value of $10 to an outstanding member of the Lehigh student branch of the ASME. This prize takes the form of associate membership for one year in the parent society.

Alpha A. Diefenderfer Award. In recognition of Professor A. A. Diefenderfer's long service as faculty adviser to the organization, the Lehigh University Chemical Society established this award for the highest-ranking senior in analytical chemistry. Each winner is presented with an engraved certificate, and the name is inscribed on a plaque displayed in the chemistry building.

Eta Kappa Nu Prize. The honorary fraternity in electrical engineering awards a handbook in electrical engineering to the highest-ranking freshman in electrical engineering.

Pi Lambda Phi Journalism Award. This is awarded to an undergraduate for outstanding editorial or business achievement in the field of publications. The trophies are made available by the local chapter of Pi Lambda Phi fraternity.

Pi Tau Sigma Prize. The honorary fraternity in mechanical engineering awards each year a mechanical engineers' handbook to the highest-ranking sophomore in mechanical engineering.

William H. Schempf Award. This award is made annually to the freshman who has shown outstanding ability and interest beyond the requirements of a normal freshman bandsman. It is made in honor of a former head of the music department by the Beta Sigma chapter of Theta Chi fraternity.

Tau Beta Pi Prize. The honorary engineering fraternity awards each year a slide rule or other prize of equivalent value to the engineering sophomore having the highest scholastic average.

BOARD OF TRUSTEES

When the year of the degree is listed, the degree was awarded by Lehigh University.

Officers of the board

Harold S. Mohler, president
Elmer W. Glick, secretary and treasurer
Paul J. Franz, Jr., assistant secretary

Corporate members

Edward A. Curtis, B.S. in Bus. Adm. '26, LL.B., LL.D.; vice president for public affairs (retired), New Jersey Bell Telephone Company.

William B. Eagleson, Jr., B.S. in Bus. Adm. '49, M.B.A., '51; chairman and president, Girard Bank, Philadelphia.

Edwin H. Gott, B.S. in I.E. '29, Eng.D. '68, Sc.D., LL.D.; chairman of the board (retired), United States Steel Corporation.

C. Lester Hogan, B.S., M.S. '47, Ph.D. '50, Hon. A.M., Eng.D., D.Sc., Eng.D. (Hon.); vice chairman, Fairchild Camera and Instrument Corporation.

Harold S. Mohler, B.S. in I.E. '48, LL.D. '75; chairman and president, Hershey Foods Corporation.

Kirk P. Pendleton, B.S., B.A. '63; vice president, Pitcairn, Incorporated.

Frank C. Rabold, B.S. in E.E. '39, Eng.D. '70; manager of general services, Bethlehem Steel Corporation.

Donald B. Stabler, B.S. in C.E. '30, M.S., LL.D. (Hon.) '74; president and chairman Stabler Companies, Incorporated.

The Rt. Rev. Dean T. Stevenson, B.A. '37, M.A. '49, S.T.B. '40, S.T.D., D.D. '69; bishop, Episcopal Diocese of Harrisburg.

Corporate members emeriti

Andrew E. Buchanan, Jr., Ch.E. '18, Eng.D.; general manager (retired); E. I. du Pont de Nemours & Company.

Allen C. DuBois, B.A. '25, LL.D.; partner (retired), Wertheim & Company.

Leonard M. Horton, B.S. in Bus. Adm. '28, LL.D.; chairman of the board (retired), Aubrey G. Lanston & Company, Incorporated.

Kenneth L. Isaacs, M.E. '25, M.B.A., LL.D.; chairman, board of trustees (retired), Massachusetts Investors Trust.

H. Randolph Maddox, M.E. '21; vice president (retired), American Telephone and Telegraph Company.

Frank L. Magee, E.E. '17, Eng.D., LL.D.; chairman of the board (retired), Aluminum Company of America.

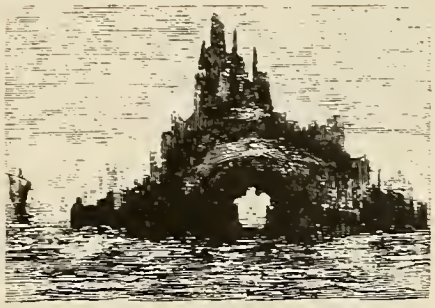

Fig. 1017.—NATURAL ARCH OF STAPI, (Iceland.)

Hugh P. McFadden, B.A. '25, LL.B., LL.D.; of counsel, Kolb Holland Antonelli & Heffner.

Ivor D. Sims, B.S. in Bus. Adm. '33, LL.D. '70; executive vice president (retired), Bethlehem Steel Corporation.

Edwin H. Snyder, E.E. '23, Eng.D. '68; board chairman and chief executive officer (retired), New Jersey Public Service Electric & Gas Company.

Members elected by alumni

The number in parentheses indicates the year the term expires.

Morgan J. Cramer, vice president and treasurer, Aminex Corporation. (1980)

Milton H. Grannatt, Jr., B.S. in Bus. Adm. '39; president, Fell & Moon Company. (1980)

William C. Hittinger, B.S. in Met. E. '44, Eng.D.; executive vice president, Consumer and Solid State Electronics, Radio Corporation of America. (1977)

Walter S. Holmes, Jr., B.S. in Bus. Adm. '41, M.B.A.; chairman, C.I.T. Financial Corporation. (1977)

Reginald A. Jennings, B.A. '70, J.D.; partner, Pickett & Jennings. (1979)

Stanley M. Richman, B.S. in Bus. Adm. '55; vice president, Lightning Electric Company. (1982)

Charles E. Swenson, B.S. in Bus. Adm. '51; partner, Swenson & Associates. (1981)

Donald J. Wikstrom, B.S. in Bus. '69; assistant manager, federal and international taxes, American Metal Climax, Inc. (1977)

Appointed trustees

The number in parentheses indicates the year the term expires.

Dexter F. Baker, B.S. in Mech. Eng. '50, M.B.A.; executive vice president, Air Products & Chemicals, Inc. (1979)

Malcolm Carrington, Jr., B.S. in Bus. Adm. '39; vice president and secretary, New Jersey Public Service Electric & Gas Company. (1980)

Lee A. Iacocca, B.S. in I.E. '45, Eng.D. (Hon.) '69; president, Ford Motor Company. (1980)

Frank G. Kear, E.E. '26, S.M., Sc.D.; partner, Kear & Kennedy. (1979)

Edmund F. Martin, M.E., Eng.D., LL.D. '67; chairman of the board and chief executive officer (retired), Bethlehem Steel Corporation. (1977)

Frederick Seitz, A.B., Ph.D., LL.D. '66; president, The Rockefeller University. (1976)

Richard M. Smith, B.S. in I.E. '48; executive vice president, Bethlehem Steel Corporation. (1981)

James H. Walker, B.A. in Econ., M.B.A.; vice president, finance (retired), Bethlehem Steel Corporation. (1975)

Honorary trustees

Alfred G. Blake, C.E. '25; chairman of the board, Engelhard Minerals & Chemicals Corporation.

S. Murray Rust, Jr., B.S. in M.E. '34; chairman of the board (retired), Rust Engineering Company.

Ralph L. Wilson, El.Met. '21, L.H.D. '68; director of metallurgy (retired), Timken Roller Bearing Company.

In Memoriam

It is with great regret that the university records the loss of four members of its board of trustees. Years of service as a trustee are noted.

W. Frederic Colclough, B.A. '25, LL.B.; chairman of the board (retired), American Bank Note Company. (1962-1976) died September 23, 1976.

Leonard P. Pool, Eng.D. '65, Sc.D., D.S.S.; chairman and chief executive officer, Air Products & Chemicals, Inc. (1964-1976) died December 27, 1975.

Monroe J. Rathbone, Ch.E. '21, Eng.D., Sc.D., LL.D.; chairman of the board (retired), Standard Oil Company (New Jersey). (1948-1976; president of the board, 1957-1973) died August 2, 1976.

Frank W. Sterrett, A.B., B.D., D.D., S.T.D., LL.D.; bishop (retired), Episcopal Diocese of Bethlehem. (1932-1954; emeritus 1959-1976) died June 29, 1976.

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The university is eager to strengthen fruitful communication with the society which it serves, and that desire motivated the establishment of visiting committees of the board of trustees.

These committees annually bring to the university representatives of industry, government, and education who study those areas of the university which they are most competent to judge, and report periodically on their evaluation of those areas.

Members of the board of trustees often serve as chairmen of the visiting committees.

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Fred Rapp, department of microbiology, Penn State University Medical Center.

Dr. William D. Reppert, internal medicine, Bethlehem.

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Agenes K. Michels, professor emeritus of classics, Bryn Mawr College.

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Weston J. Burner, director, Information Processing Center, Massachusetts Institute of Technology.

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Raffee Ellis, director, Computing Center, University of Pittsburgh.

Dr. Stephen G. Goldmann, Exxon Corporation, Houston, Texas.

Paul J. Plourde, director, Three College Computer Center, Amherst College, Amherst, Mass.

Dr. James F. Poage, director of university computing, Princeton University.

Vladimir Slamecka, director, Georgia Institute of Technology, School of Information and Computer Science, Atlanta.

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John Heiss, New England Conservatory of Music, Boston.

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Warren Smith, coordinator, campus program in arts, Pennsylvania State University.

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Ralph L. Wilson, honorary member.

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G. B. Herzog, director, Solid State Technology Center, RCA, Somerville, N.J.

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William Digel, Wilmington, Del.

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Edwin H. Miller, professor of English, New York University.

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Dr. Lawrence H. Lattman, Cultural Affairs Office, U.S. Embassy.

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The Hon. Robert Clifford, Supreme Court Chambers, Trenton, N.J.

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Theodore J. Lowi, department of political science, Cornell University.

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Dankwart Rustow, distinguished professor of political science, City University of New York.

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Laurence C. Howard, dean, the Graduate School, University of Pittsburgh.

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Merrill D. Peterson, Corcoran department of history, University of Virginia.

Dr. Lawrence W. Towner, director, The Newberry Library, Chicago, Ill.

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James Hosford, vice president-manufacturing and electronic components, Western Electric Company, Newark, N.J.

Stephen F. Miketic, vice president, Westinghouse Electric Corporation, Pittsburgh, Pa.

Dr. Paul Torgersen, dean, College of Engineering, Virginia Polytechnic Institute.

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Percy E. Corbett, professor emeritus, Princeton University.

Alvin Z. Rubinstein, department of political science, University of Pennsylvania.

Marshall Shulman, director, Russian Institute, Columbia University.

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David Kaser, director of libraries, Cornell University.

Jay K. Lucker, director of libraries, Massachusetts Institute of Technology.

Thomas H. Mott, dean, Graduate School of Library Science, Rutgers University.

Dr. Jack Vanderryn, U.S. Atomic Energy Commission, Washington, D.C.

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Dr. John D. Costlow, director, Duke University Marine Laboratory, Beaufort, N.C.

William S. Gardner, president, Woodward-Clyde Associates, Plymouth Meeting, Pa.

Dr. George H. Keller, director, Marine Geology & Geophysics Laboratory, Atlantic Oceanographic Laboratory, National Oceanic and Atmospheric Administration, Miami, Fla.

Dr. Walter J. Nickerson, Rutgers University.

Roy F. Weston, Roy F. Weston, Inc., West Chester, Pa.

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Hyman Bass, department of mathematics, Columbia University.

Dr. Laurence B. Heilprin, professor of information science, University of Maryland.

Daniel H. Wagner, Daniel H. Wagner Associates, Paoli, Pa.

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Raymond Cohen, director, Herrich Laboratories, Purdue University.

Dr. John W. Hutchinson, department of applied physics and engineering, Harvard University.

Hustace Hubbard Poor, vice president, research and development, Babcock & Wilcox Company.

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Dr. Robert J. Sanatro, Manhasset Hills, N.Y.

S. F. Snyder, manager, new technology development department, Ford Motor Company, Dearborn, Mich.

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Eric Baer, Case-Western Reserve University.

Dr. N. Bruce Hannay, Bell Telephone Laboratories.

Edward H. Kottcamp, assistant to the vice president, Homer Research Laboratories, Bethlehem Steel Corporation.

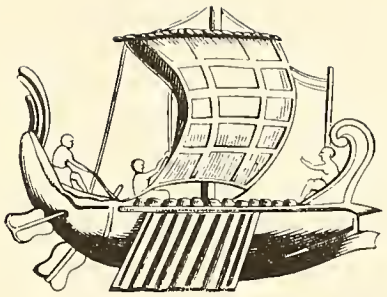

Fig. 142.

Dr. Michael V. Nevitt, deputy laboratory director, research, Argonne National Laboratory.

W. O. Philbrook, department of metallurgy and materials science, Carnegie-Mellon University.

L. H. Van Vlack, department of metallurgy and materials science, University of Michigan.

Modern Foreign Languages

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Dr. Frank Bergmann, chairman, department of humanities, Utica College of Syracuse University.

Sinan Korle, chief of protocol, United Nations.

Dr. Eugene Sekulow, vice president, international division, RCA Corporation.

Dr. Edward Sullivan, professor of French, Princeton University.

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Joel Feinberg, department of philosophy, Rockefeller University.

Frederick Ferre, department of philosophy, Dickinson College.

Dr. Nicholas Rescher, department of philosophy, University of Massachusetts.

Judith Thomson, department of philosophy, Massachusetts Institute of Technology.

Physics

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Robert H. Dicke, department of physics, Princeton University.

R. S. Knox, department of physics and astronomy, University of Rochester.

Psychology

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Edward Joseph Shoben, Jr., associate provost, University of Pittsburgh.

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Dr. Benjamin Minifie, Newport, R.I.

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Dr. Russell Rowlett, Jr., editor, Chemical Abstracts Service, Ohio State University.

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Fig. 220.—ASTER DUMOSIS. (New American rose-variety.)

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Brian Hill, basketball coach
Gerald Leeman, golf coach
Barbara Lipkin, volleyball and lacrosse coach
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Annette Lynch, women's basketball coach
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Joan Peto, women's swimming coach
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Carol D. Rauch, librarian
John H. Morrison, operations manager
Louis P. Robinson, B.E., special projects manager
William E. Schiesser, Ph.D., analyst, computing center

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George P. Hoskin, Ph.D., comparative physiology; lipid biochemistry
Jiunn W. Huang, Ph.D., virology; microbiology; oncogenesis
George J. Jackson, Ph.D., nematode physiology; immunology; parasitology of foods
Lothar P. Renwrantz, D.Sc., immunology
Carl J. Sindermann, Ph.D., diseases of marine invertebrates and fish
Randall W. Snyder, Jr., M.D., gastrointestinal physiology; medical parasitology
Timothy P. Yoshino, Ph.D., comparative immunology; experimental parasitology

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Ned D. Heindel, Ph.D., director; medicinal chemistry, nuclear medicine; cancer chemotheraphy; bioorganic chemistry
Brent W. Benson, Ph.D., radiation biophysics; structure of nucleic acids
Frederick M. Fowkes, Ph.D., physical chemistry of biological surfaces
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William E. Ohnesorge, Ph.D., clinical chemistry
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James E. Sturm, Ph.D., radiochemistry as applied to living systems
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Russell E. Benner, Ph.D., prosthetics
Nikolai Eberhardt, Ph.D., bioinstrumentation
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Raymond G. Cowherd, Ph.D., social welfare, causal relationships between poverty and ill health
George A. Dinsmore, Ph.D., application of systems simulation to health services delivery
John R. McNamara, Ph.D., public health economics and modeling
John J. O'Connor, Ph.D., biomedical information retrieval systems
Eli Schwartz, Ph.D., cost-benefit analysis of medical research; health service administration; hospital administration
Albert C. S. Shen, Ph.D., econometrics; health economics
Roger D. Simon, Ph.D., quantitative techniques for the study of sanitary services' morbidity and mortality rates

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Bruce M. Smackey, Ph.D., economics of health services
Robert C. Williamson, Ph.D., medical and public health sociology

Center for Information Science

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Herbert Rubenstein, Ph.D., psycholinguistics
John J. O'Connor, Ph.D., information retrieval
Robert F. Barnes, Jr., Ph.D., mathematical linguistics
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John E. Walker, Ph.D., computing liaison
Lynn S. Beedle, Ph.D., tall buildings information system

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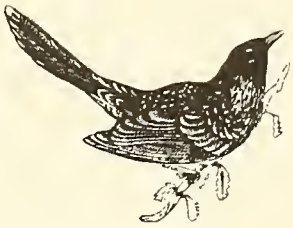

Fig. 145.—BRUSH WATTLE-BIRD.
(*Anthochara mellivora.*)

Fritz Engineering Laboratory

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Sarah-Louise Melcher, B.A., administrative assistant to the director
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Hsai-Yang Fang, Ph.D., director, geotechnical engineering division
Robert L. Johnson, Ph.D., director, hydraulics and environmental engineering division
Le-Wu Lu, Ph.D., director, building systems division
Ti Huang, Ph.D., director, structural concrete division
George C. Driscoll, Jr., Ph.D., director, structural connections division
Alexis Ostapenko, Ph.D., director, structural stability division
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Richard M. Spriggs, Ph.D., physical ceramics laboratory

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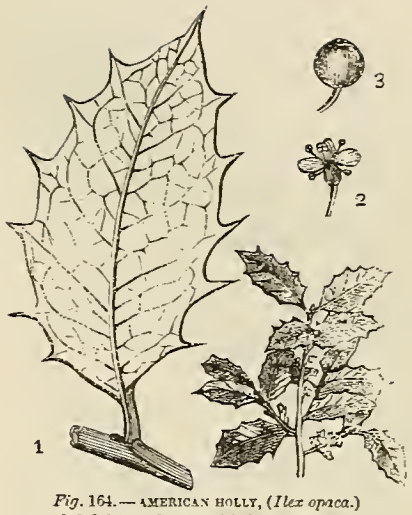

Fig. 164.— AMERICAN HOLLY, (*Ilex opaca.*)
1, 2, 3, leaves, flower, and fruit; natural size.

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Institute for Metal Forming

Betzalel Avitzur, Ph.D., director

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David M. Bell, Ph.D., behavior of marine animals
Bobb Carson, Ph.D., geological oceanography
Edward B. Evenson, Ph.D., geomorphology and quaternary geology
Robert J. Johnson, Ph.D., tertiary sewage treatment
K. Elaine Hoagland, Ph.D., marine ecology and reproductive strategies
Richard G. Malsberger, Ph.D., viral diseases of fish
Joseph R. Merkel, Ph.D., biochemistry of marine bacterial enzymes
James M. Parks, Ph.D., beach preservation
Hayden N. Pritchard, Ph.D., marine botany
J. Donald Ryan, Ph.D., geological history of coastal salt marshes, sedimentation

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Fig. 581. — CHICAGO IN 1830.

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John H. Fergus (1974), assistant professor of aerospace studies. B.S., Lehigh, 1967; M.S., 1969. Captain, U.S.A.F.

Jacqueline M. Fetsko (1949, 1966), assistant research director, National Printing Ink Research Institute, and administrative assistant, Center for Surface and Coatings Research. B.A., Pennsylvania, 1946; M.S., Lehigh, 1953.

Elizabeth N. Fifer (1973), assistant professor of English. B.A., Michigan, 1965; M.A., 1966; Ph.D., 1969.

Patricia A. Finady (1971), administrative assistant, counseling service. B.A., Moravian, 1965.

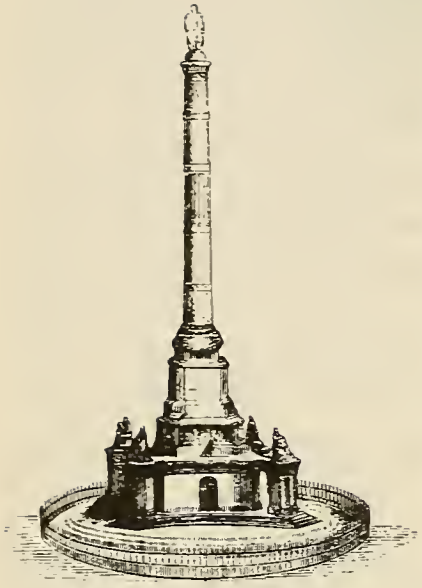


Fig. 582. — DOUGLAS MONUMENT.

William J. Fincke, Jr. (1972), interlibrary loan librarian, Linderman Library. B.A., New York at Oneonta, 1970; M.L.S., New York at Albany, 1971.

Laurence Fink (1976), instructor in fine arts.

John W. Fisher (1961, 1969), professor of civil engineering, and associate director, Fritz Engineering Laboratory. B.S., Washington, 1956; M.S., Lehigh, 1958; Ph.D., 1964. P.E., Illinois, 1960.

Thomas Fleck, Jr. (1965, 1970), director, Centennial School. B.S., West Chester, 1956; M.Ed., Temple, 1960; Ed.D., Lehigh, 1970.

Catherine L. Flecksteiner (1945, 1965), serials cataloger, university libraries.

Hubert L. Flesher (1971, 1975), university chaplain, and associate professor of religion studies. M.Div., Pomona, 1954; B.D., Yale, 1958; M.A., 1961.

Robert T. Folk (1961, 1966), professor of physics. B.S. in E.E., Lehigh, 1953; B.S. in Phys., 1954; M.S., 1955; Ph.D., 1958.

Roy Foster, Jr. (1967), assistant director, public information. A.B., Ursinus, 1951.

Frederick M. Fowkes (1968), professor and chairman of chemistry. B.S., Chicago, 1936; Ph.D., 1938.

W. Beall Fowler, Jr. (1966, 1969), professor of physics. B.S., Lehigh, 1959; Ph.D., Rochester, 1963.

James R. Frakes (1958, 1974), Edmund W. Fairchild professor of American studies. B.A., Penn State, 1948; M.A., Chicago, 1949; Ph.D., Pennsylvania, 1953.

Barbara B. Frankel (1973), assistant professor of cultural anthropology. Ph.B., Chicago, 1947; B.A., Goddard, 1966; M.A., Temple, 1970; M.A., Princeton, 1971; Ph.D., 1973.

Catherine Franklin (1959, 1971), director of central copying and mailing.

Paul J. Franz, Jr. (1944, 1962), vice president for development. B.S. in Bus. Adm., Lehigh, 1944; M.A., 1955.

Linton C. Freeman (1973), Lucy G. Moses distinguished professor of sociology. B.A., Roosevelt, 1952; M.A., Hawaii, 1953; Ph.D., Northwestern, 1956.

Janet L. Freudenberg (1973), personnel analyst. B.A., Bates, 1970.

Sharon M. Friedman (1974), assistant professor of journalism/English. B.A., Temple, 1964; M.A., Penn State, 1974.

Albert F. Fries, Jr. (1975), instructor in accounting. B.A., Lehigh, 1963; M.B.A., 1968.

Bruce D. Fritchman (1969, 1972), associate professor of electrical engineering. B.S., Lehigh, 1960; E.P., 1961; M.S., 1963; Ph.D., 1967.

Anna M. Fritz (1971, 1975), manager, Saucon Married and Graduate Students apartments.

Nancy C. Fulford (1976), health professions coordinator. B.A., Pennsylvania, 1956.

Gail A. Fullman (1972, 1974), data controller, control group. B.A., Susquehanna, 1972.

John T. Fulton (1974), assistant director of development. B.S., Lehigh, 1965; M.A., 1967.

G

Matthew W. Gaffney (1971), associate professor of education. A.B., Hobart, 1935; M.A., Rochester, 1941; Ed.D., Buffalo, 1953.

Edward J. Gallagher (1969, 1974), associate professor of English, and director, Humanities Perspectives on Technology. B.S., St. Joseph's, 1964; Ph.D., Notre Dame, 1970.

Gerald Garb (1967), professor of economics. B.S., Pennsylvania, 1948; M.A., Berkeley, 1951; Ph.D., 1957.

J. Bruce Gardiner (1972), instructor in physical education, and head swimming coach. B.S., Springfield, 1968; M.Sc., 1972.

Arthur P. Gardner (1958, 1966), associate professor of German. A.B., Duke, 1944; A.M., Harvard, 1945; Ph.D., 1950.

James J. Garrigan (1972), Centennial School psychologist. A.B., Seton Hall, 1963; M.A., 1965; Ed.D., Lehigh, 1975.

Austin Gavin (1974), executive consultant, office of the president. A.B., Ursinus, 1930; LL.B., Pennsylvania, 1933; LL.D., Ursinus, 1974.

Jacob M. Geist (1959), lecturer in chemical engineering. B.S., Purdue, 1940; M.S., Penn State, 1942; Ph.D., Michigan, 1950.

Herman F. George (1976), research associate in chemical engineering. B.A., Lehigh, 1970; B.S., 1971; M.S., 1972.

Ann A. Gerber (1959, 1964), administrative assistant to the dean and vice president for student affairs.

Bhaskar K. Ghosh (1961, 1968), professor of mathematics. B.Sc., Calcutta (India), 1955; Ph.D., London, 1959.

Agnes B. Gifford (1964, 1975), administrative assistant, treasurer's office.

Elmer W. Glick (1949, 1972), vice president and treasurer. B.A., Lehigh, 1933.

William M. Glose III (1960, 1967), accountant. B.S. in Bus. Adm., Lehigh, 1958.

Hans R. Gnerlich (1967, 1975), assistant professor of electrical engineering. Dipl. Ing., Technical (Karlsruhe), 1967; M.S., Lehigh, 1969; Ph.D., Lehigh, 1975.

Joseph I. Goldstein (1968, 1975), Theodore L. Diamond professor of metallurgy and materials science. B.S., M.I.T., 1960; S.M., 1962; Sc.D., 1964.

Arthur F. Gould (1947, 1974), professor and associate dean of the College of Engineering and Physical Sciences. S.B., M.I.T., 1938; M.S., Lehigh, 1949. P.E., Pennsylvania, 1949.

Margaret C. Grandovic (1962, 1974), associate professor of education. B.S., Temple, 1938; M.Ed., 1957; Ed.D., 1968.

David M. Greene (1958, 1964), professor of English. B.A., San Diego State, 1951; M.A., Berkeley, 1952; Ph.D., 1958.

James A. Greenleaf (1970, 1974), assistant professor of management and finance. B.S., Penn State, 1964; M.S., Lehigh, 1966; Ph.D., N.Y.U., 1974.

Mikell P. Groover (1966, 1973), associate professor of industrial engineering. B.A., Lehigh, 1961; B.S., 1962; M.S., 1966; Ph.D., 1969.

Charles Guditus (1964, 1973), professor of education, and director, division of educational administration, School of Education. B.S., Penn State, 1950; M.S., Bucknell, 1952; Ed.D., Lehigh, 1965.

Samuel L. Gulden (1953, 1967), associate professor of mathematics. B.S., City College of New York, 1949; M.A., Princeton, 1950.

H

Clark W. Hahn (1963, 1967), assistant accountant, B.A., Muhlenberg, 1972.

Walter C. Hahn, Jr. (1967, 1972), professor of metallurgy and materials science. B.S., Lafayette, 1952; M.S., Penn State, 1958; Ph.D., 1960.

John M. Haight, Jr. (1949, 1967), professor of history. A.B., Princeton, 1940; M.A., Yale, 1947; Ph.D., Northwestern, 1953.

Theodore Hailperin (1946, 1961), professor of mathematics. B.S., Michigan, 1939; Ph.D., Cornell, 1943.

Carol F. Hammett (1976), Centennial School teacher. B.S., Moore, 1966.

James E. Hansz (1974), associate professor of marketing. A.B., Albion, 1964; M.B.A., Michigan State, 1965; Ph.D., Cincinnati, 1971.

John E. Hare (1974, 1975), assistant professor of philosophy. B.A., Oxford, 1971; Ph.D., Princeton, 1975.

Kenneth R. Harpel (1936, 1969), superintendent, Fritz Engineering Laboratory.

James W. Harper (1971), director of community relations. B.S., Northwestern, 1954; M.S., 1956.

Nathan W. Harris (1970), assistant dean of students. B.A., Lincoln, 1965.

William R. Harris (1974, 1976), assistant director, computing center. B.A., Temple, 1965; M.B.A., 1975.

Robert R. Harson (1966, 1973), associate professor of English. B.A., Wagner, 1963; M.A., Ohio, 1964; Ph.D., 1966.

Ronald J. Hartranft (1966, 1972), associate professor of mechanics. B.S., Lehigh, 1963; M.S., 1964; Ph.D., 1966.

Albert E. Hartung (1947, 1968), distinguished professor of English. B.A., Lehigh, 1947; M.A., 1949; Ph.D., 1957.

Lawrence Hasbrouck (1975), professor of aerospace studies. B.A., Colgate, 1953; M.B.A., Ohio State, 1967. Colonel, U.S.A.F.

Thomas M. Haynes (1952, 1969), professor of philosophy, and director, freshman seminars. A.B., Butler, 1941; M.A., Illinois, 1949; Ph.D., 1949.

Stanley F. Heffner (1930, 1946), manager, university bookstore.

Ned D. Heindel (1966, 1973), Howard S. Bunn distinguished professor of chemistry, and director, division of biological chemistry and biophysics, Center for Health Sciences. B.S., Lebanon Valley, 1959; M.S., Delaware, 1961; Ph.D., 1963.

Sidney S. Herman (1962, 1971), professor of biology, and director, The Wetlands Institute. B.S., Georgetown, 1953; M.S., Rhode Island, 1958; Ph.D., 1962.

Roy C. Herrenkohl (1966, 1975), professor of social psychology and methodology, and director, behavioral science program, Center for Social Research. B.A., Washington & Lee, 1954; Ph.D., N.Y.U., 1966.

Richard W. Hertzberg (1964, 1973), professor of metallurgy and materials science. B.S., City College of New York, 1960; M.S., M.I.T., 1961; Ph.D., Lehigh, 1965.

Anna P. Herz (1966, 1972), professor of Russian. B.S., Pennsylvania, 1949; M.A., 1950; M.A., Columbia, 1951; Ph.D., Pennsylvania, 1956.

Warren R. Heydenberk (1973), assistant professor of education. B.S., Western Michigan, 1964; M.A., 1965; Ed.D., Northern Colorado, 1971.

Frank H. Hielscher (1971, 1975), associate professor of electrical engineering. B.S., Drexel, 1961; M.S., Denver, 1963; Ph.D., Illinois, 1966.

Brian Hill (1974), instructor in physical education, and head basketball coach. B.A., Kennedy, 1969.

James Hill (1977), assistant professor of speech and drama. B.F.A., Goodman School of Drama, 1952; M.F.A., Art Institute of Chicago, 1953.

Mary J. Hill (1967), editorial associate, office of research. B.S., Carnegie-Mellon, 1959; M.A., Pittsburgh, 1964.

John L. Hilley (1976), assistant professor of economics. B.A., Princeton, 1970; Ph.D., 1976.

Donald J. Hillman (1960, 1964), professor of information sciences, and director, Center for Information Science. B.A., Cambridge (England), 1955; M.A., 1959; M.Litt., 1962.

Peter D. Hilton (1969, 1974), associate professor of mechanical engineering and mechanics. B.S., Lehigh, 1965; M.S., Harvard, 1966; Ph.D., 1969.

Terence J. Hirst (1968, 1973), associate professor of civil engineering and associate director, Marine Geotechnical Laboratory. B.A.S., British Columbia, 1962; M.A.S., 1966; Ph.D., Berkeley, 1968.

K. Elaine Hoagland (1975), assistant professor of biology. B.A., Pomona, 1970; Ph.D., Harvard, 1975.

James B. Hobbs (1966, 1970), professor of management and accounting. A.B., Harvard, 1952; M.B.A., Kansas, 1957; D.B.A., Indiana, 1962.

Michael R. Hodges (1974), assistant professor of international relations. B.A., Cambridge (England), 1966; M.A., 1970; Ph.D., Pennsylvania, 1973.

Wayne Hoffman (1968, 1973), assistant director, administrative systems office.

Robert M. Holcombe (1963, 1968), director of development. B.S., Lehigh, 1958; M.S., 1969.

Joseph P. Holzer (1970), administrative assistant, computing center.

Carl S. Holzinger (1959, 1968), associate professor of electrical engineering. B.S., Lehigh, 1956; M.S., 1957; Ph.D., 1963.

Frank S. Hook (1952, 1965), professor and chairman of English. A.B., Missouri, 1942; M.A., 1947; Ph.D., Yale, 1952.

Leslie Horst (1973, 1976), assistant professor of psychology. B.A., Radcliffe, 1967; Ph.D., Michigan, 1976.

Raymond L. Horton (1974), assistant professor of marketing. B.S., Maryland, 1966; M.B.A., Indiana, 1968; D.B.A., 1973.

Chuan-Chih Hsiung (1952, 1960), professor of mathematics. B.S., National Chekiang (China), 1936; Ph.D., Michigan State, 1948.

Ti Huang (1967, 1975), professor of civil engineering. B.S., Tangshan Engineering, 1948; M.S., Michigan, 1952; Ph.D., 1960.

Michael C. Hughes (1975), assistant professor of chemistry. B.S., S.U.N.Y. at Albany, 1965; Ph.D., Syracuse, 1971.

John W. Hunt (1972, 1973), dean of the College of Arts and Science, and professor of English. B.A., Oklahoma, 1949; B.D., 1952; Ph.D., Chicago, 1961.

Deborah S. Husson (1975), Centennial School teacher. B.S., Millersville State, 1973.

Allen E. Hye (1973), assistant professor of German. B.A., Franklin and Marshall, 1966; M.A., Middlebury, 1967; Ph.D., Connecticut, 1972.

I

Jon T. Innes (1965, 1973), associate professor of economics. B.S., Penn State, 1958; M.A., Oregon, 1961; Ph.D., 1967.

J

Thomas E. Jackson (1937, 1969), professor of mechanical engineering. B.S., Carnegie-Mellon, 1934; M.S., Lehigh, 1937. P.E., Pennsylvania, 1946.

E. Anthony James (1962, 1972), associate professor of English. A.B. Princeton, 1958; M.A., Pennsylvania, 1960; Ph.D., 1965.

George R. Jenkins (1948, 1963), director of the office of research, and professor of geology. B.A., Colorado, 1936; Ph.M., Wisconsin, 1938.

Frances M. Jennings (1974), Centennial School teacher. B.A., Lenoir Rhyne, 1956.

Finn B. Jensen (1947, 1954), MacFarlane professor in theoretical economics, and chairman of economics. A.B., Southern California, 1934; M.A., 1935; Ph.D., 1940.

Roger M. John (1975), associate professor of military science. B.A., Texas A&M, 1963; M.A., 1966. Major, U.S. Army.

Robert L. Johnson (1970, 1972), associate professor of civil engineering, and director, environmental engineering laboratory, CMES. B.S., Iowa State, 1957; M.S., 1963; Ph.D., 1969. P.E., Iowa.

Stanley H. Johnson (1973, 1976), associate professor of mechanics. B.S., California, 1962; M.S., 1967; Ph.D., 1973.

Richard M. Jones (1975), director, fraternity management association. B.S., St. Francis, 1968.

Donald D. Joye (1976), assistant professor of chemical engineering. B.S.E., Princeton, 1967; M.S., Lehigh, 1969; Ph.D., 1972.

Carey B. Joynt (1951, 1960), Monroe J. Rathbone professor of international relations. B.A., Western Ontario, 1945; M.A., 1948; Ph.D., Clark, 1951.

Safeta S. Juka (1972), assistant professor of French. Lic. es lettres, Sorbonne, 1950; Dr. d'Univ., 1969.

K

Arturs Kalnins (1965, 1967), professor of mechanics, and director, division of bioengineering, Center for Health Sciences. B.S., Michigan, 1955; M.S., 1956; Ph.D., 1960.

George E. Kane (1950, 1964), professor and chairman of industrial engineering. B.S., Penn State, 1948; M.S., Lehigh, 1954. P.E., Pennsylvania, 1955.

Alvin S. Kanofsky (1967, 1976), professor of physics. B.A., Pennsylvania, 1961; M.S., 1962; Ph.D., 1966.

Jerome T. Kapes (1974), associate professor of education. B.S., Penn State, 1967; M.Ed., 1968; Ph.D., 1971.

John J. Karakash (1946, 1966), distinguished professor and dean of the College of Engineering and Physical Sciences. B.S., Duke, 1937; M.S., Pennsylvania, 1938; Eng.D., Lehigh, 1971. P.E., Pennsylvania, 1948.

Andrew James Kasarda (1968, 1971), associate professor of information sciences, and associate director, Center for Information Science. B.A., Penn State, 1962; M.S., Lehigh, 1966; Ph.D., 1968.

Laura Katz-Olson (1974), assistant professor of government. B.A., City Univ. of New York, 1967; M.A., Colorado, 1971; Ph.D., 1974.

Edwin J. Kay (1971), assistant professor of psychology. B.A., Rensselaer, 1964; M.S., Lehigh, 1966; Ph.D. (mathematics), 1968; Ph.D. (psychology), 1971.

Jacob Y. Kazakia (1972, 1974), assistant professor, Center for the Application of Mathematics. M.Sc., Istanbul Tech., 1968; Ph.D., Lehigh, 1972.

John D. Keefe (1965, 1975), associate professor of economics. B.S., Lehigh, 1948; M.A., Miami, 1955.

John L. Kemmerer (1966, 1974), purchasing agent.

Joseph E. Kempfer (1976), Centennial School teacher. B.A., Moravian, 1974; M.Ed., Lehigh, 1976.

Joseph P. Kender (1968, 1971), associate professor of education. A.B., Mt. St. Mary's, 1952; M.A., Villanova, 1955; Ed.D., Pennsylvania, 1967.

J. Patrick Kennedy (1975), assistant basketball coach and assistant track coach. B.A., Kings, 1975.

Samir A. Khabbaz (1960, 1968), professor of mathematics. B.A., Bethel, 1954; M.A., Kansas, 1956; Ph.D., 1960.

Linda Kharti (1977), reference librarian, Mart Library. B.A., Kirkland, 1972; M.L.S., Pittsburgh, 1976.

Yong Wook Kim (1968, 1973), associate professor of physics. B.S., Seoul National, 1960; M.S., 1962; Ph.D., Michigan, 1968.

Arthur E. King (1976), assistant professor of economics. A.B., Middlebury, 1971; M.A., Ohio State, 1973; Ph.D., 1976.

Jerry P. King (1962, 1968), professor of mathematics. B.S., Kentucky, 1958; M.S., 1959; Ph.D., 1962.

William P. Kiss (1973), assistant superintendent and plant engineer, buildings and grounds.

Lynn D. Klein (1970, 1974), assistant to the director of physical planning. B.A., Muhlenberg, 1970.

Ronald O. Klein (1976), assistant football coach. B.S., Delaware, 1972; M.S., 1975.

Kamil Klier (1967, 1973), professor of chemistry. Dipl. Chem., Charles (Prague), 1954; C.S.C. (RN Dr.), Czechoslovakia Academy of Science (Prague), 1961.

Alfred P. Koch (1946, 1961), professor of accounting. B.S., Bloomsburg State, 1939; M.S., Bucknell, 1940. C.P.A., Pennsylvania, 1952.

Richard Kofsky (1977), residence area coordinator. B.A., Trenton State, 1974; M.Ed., 1976.

Winfred Kohls (1969), adjunct professor of history. B.A., Augustana, 1951; M.A., Berkeley, 1959; Ph.D., 1967.

Barbara K. Kopytoff (1976), assistant professor of cultural anthropology. B.A., Swarthmore, 1960; M.A., 1964; Ph.D., Pennsylvania, 1973.

Philip G. Kosky (1976), associate professor of mechanical engineering. B.S., Univ. Col., London, 1961; M.S., Berkeley, 1963; Ph.D., 1966.

Celal N. Kostem (1966, 1972), associate professor of civil engineering. B.S., Technical of Istanbul, 1960; M.S., 1961; Ph.D., Arizona, 1966.

R. Wayne Kraft (1962, 1965), New Jersey Zinc professor of metallurgy and materials science. B.S., Lehigh, 1948; M.S., Michigan, 1956; Ph.D., 1958.

Charles S. Kraihanzel (1962, 1970), professor of chemistry. Sc.B., Brown, 1957; M.S., Wisconsin, 1959; Ph.D., 1962.

Steven Krawiec (1970, 1976), associate professor and chairman of biology. A.B., Brown, 1963; Ph.D., Yale, 1968.

Barbara Kreppel (1976), administrative assistant, residence operations. B.A., Frostburg State, 1975.

Joseph R. Kress (1971), instructor of military science. Sergeant Major, U.S. Army.

Leon E. Krouse (1951, 1963), associate professor of finance. B.A., Susquehanna, 1941; M.S., Bucknell, 1947; Ph.D., New York, 1958.

Michael W. Kubinec (1973, 1976), personnel associate. B.S., Lehigh, 1973.

Anastasios Kydoniefs (1969, 1973), associate professor, Center for the Application of Mathematics. B.Sc., Athens (Greece), 1963; M.Sc., Nottingham (England), 1965; Ph.D., 1967.

L

Thomas J. Laffey (1973), instructor in education. B.A., St. Francis (Loretto, Pa.), 1965; M.S.S., Bryn Mawr, 1973.

Arthur I. Larky (1954, 1964), professor of electrical engineering. B.S., Lehigh, 1952; M.S., Princeton, 1953; Ph.D., Stanford, 1957.

Adele E. Laslie (1976), instructor in philosophy. B.A., Sweet Briar, 1967; M.A., Johns Hopkins, 1972.

Bruce A. Laub (1965, 1968), administrative associate, Fritz Engineering Laboratory. B.S., Lehigh, 1961; M.B.A., 1968.

William B. Leckonby (1946, 1962), director of athletics and recreation. B.S., Lawrence, 1939.

Lawrence H. Leder (1968), professor and chairman of history, and coordinator, Lawrence Henry Gipson Institute for Eighteenth-Century Studies. B.A., Long Island, 1949; M.A., N.Y.U., 1950; Ph.D., 1960.

David C. Lee (1975), director of operations, residence halls. B.A., California at Riverside, 1970; M.A., Michigan State, 1973.

Janeen P. Lee (1976), Centennial School teacher. B.A., California at Riverside, 1969.

Gerald G. Leeman (1950, 1970), assistant professor of physical education, and golf coach. B.A., State College of Iowa, 1948.

Daniel Leenov (1963, 1976), professor of electrical engineering. B.S., George Washington, 1943; M.S., Chicago, 1948; Ph.D., 1951.

Linda S. Lefkowitz (1974), assistant professor of Spanish. B.A., Queens, 1964; M.A., Berkeley, 1968; M.A., Princeton, 1970; Ph.D., 1973.

Henry Leidheiser, Jr. (1968), professor of chemistry, and director, Center for Surface and Coatings Research. B.S., Virginia, 1941; M.S., 1943; Ph.D., 1946.

Robert L. Leight (1963, 1969), associate professor of education, and director, division of secondary education, School of Education. B.S., Kutztown State, 1959; M.A., Lehigh, 1961; M.Ed., 1964; Ed.D., 1966.

Robert E. Lentz (1973), associate director, health service. A.B., Pennsylvania, 1937; M.D., Temple, 1941.

Edward K. Levy (1967, 1976), professor of mechanical engineering and mechanics. B.S., Maryland, 1963; S.M., M.I.T., 1964; Sc.D., 1967.

Fig. 443. — BUFFALO, (*Bos bubalus.*)

Deming Lewis (1964), president. A.B., Harvard, 1935; B.A., Oxford, 1938; Ph.D., Harvard, 1941; M.A., Oxford, 1945; LL.D., Lafayette, 1965; L.H.D., Moravian, 1966; LL.D., Muhlenberg, 1968; Eng. D., Lehigh, 1974.

Joseph F. Libsch (1946, 1969), Alcoa professor of metallurgy and materials science, and vice president for research. B.S., M.S., M.I.T., 1940; Sc.D., 1941. P.E., Pennsylvania, 1947.

John O. Liebig, Jr. (1946, 1970), professor of civil engineering. B.S., Lehigh, 1940; M.S., 1949. P.E., Pennsylvania, 1951.

Thelma Lifland (1971), instructor in School of Education. B.A., Brooklyn, 1956; M.Ed., Rutgers, 1960.

J. Ralph Lindgren (1965, 1969), associate professor and chairman of philosophy. B.S., Northwestern, 1959; M.A., Marquette, 1961; Ph.D., 1963.

Barbara Lipkin (1974), instructor in physical education, and lacrosse coach. B.S., West Chester, 1970; M.S., Penn State, 1974.

Lora Liss (1974), affirmative action officer. B.A., Queens, 1965; M.A., N.Y.U., 1967; Ph.D., 1969.

Benjamin Litt (1970, 1973), associate professor of management. B.S., Brooklyn Polytechnic, 1950; M.S., Stevens, 1957; M.B.A., N.Y.U., 1964; Ph.D., 1970.

Roger C. Loeb (1971), assistant professor of psychology. A.B., Bucknell, 1967; Ph.D., Cornell, 1972.

Barbara Long (1966, 1971), programmer/analyst, administrative systems office.

Larry E. Long (1976) assistant professor of industrial engineering. B.S., Oklahoma, 1967; M.S., 1971; Ph.D., 1974.

Robert M. Lospinoso (1976), residence area coordinator. A.A., Union, 1972; B.A., Trenton, 1974; M.Ed., 1976.

Roland W. Lovejoy (1962, 1976), professor of chemistry. B.A., Reed, 1955; Ph.D., Washington State, 1960.

Le-Wu Lu (1957, 1969), professor of civil engineering. B.S., National Taiwan, 1954; M.S., Iowa State, 1956; Ph.D., Lehigh, 1960.

Robert A. Lucas (1958, 1969), associate professor of mechanical engineering. B.S., Lehigh, 1957; M.S., 1959; Ph.D., 1964.

John Luckhardt (1973), assistant football coach, instructor in physical education, and assistant lacrosse coach. B.S., Purdue, 1967; M.S., 1970.

Feng-Shyand Luh (1965, 1968), associate professor of accounting. B.A., National Taiwan, 1957; M.S., Illinois, 1961; Ph.D., Ohio State, 1965.

James C. Luizer (1976), instructor of economics. B.S., Lehigh, 1973; M.A., 1975.

J. Gary Lutz (1971, 1976), associate professor of education. B.S., Lehigh, 1965; M.A., 1968; Ed.D., 1969.

William L. Luyben (1967, 1973), professor of chemical engineering. B.S., Penn State, 1955; M.B.A., Rutgers, 1958; M.S., 1962; Ph.D., Delaware, 1963.

M

George B. MacDonald (1964, 1972), assistant professor of English. A.B., Boston College, 1962; M.A., Lehigh, 1964; Ph.D., 1972.

Helen P. Mack (1974), science cataloger, university libraries. B.A., Moravian, 1973; M.S.L.S., Drexel, 1974.

James D. Mack (1946, 1976), curator, rare book collection. B.A., Lehigh, 1938; M.A., 1949.

Alister K. MacPherson (1971, 1974), professor of mechanical engineering and mechanics. B.S., Sydney (Australia), 1957; M.S., 1965; Ph.D., 1967.

Mary I. Malone (1966), secretary to the president. B.A., Rosary, 1945.

Richard G. Malsberger (1959, 1976), professor of biology. B.A., Lehigh, 1948; M.S., 1949; Ph.D., 1958.

Arthur H. Mann (1965, 1970), associate dean of students. B.A., Wesleyan, 1940; S.T.B., General Theological Seminary, 1944.

John L. Manni (1976), assistant professor of education. B.S., West Chester State, 1966; M.Ed., Temple, 1968; Ed.D., 1975.

Harold R. Manns (1974), assistant professor of military science. B.S., Lehigh, 1965; M.B.A., 1974. Captain, U.S. Army.

John A. Manson (1966, 1971), professor of chemistry, and director of the polymer laboratory, Materials Research Center. B.Sc., McMaster (Ontario), 1949; M.Sc., 1950; Ph.D., 1956.

David L. March (1969, 1976), director, administrative systems office. B.S., Lehigh, 1964; M.Ed., 1965; Ed.D., 1970.

Dale R. Martin (1975), instructor in accounting. B.S., Illinois State, 1968; M.S., 1969.

Martin M. Masiuk (1973, 1975), assistant professor of modern foreign languages. B.A., Rosemont, 1967; M.A., Bryn Mawr, 1969; Ph.D., 1976.

James P. Mathews (1947), physiotherapist, health service.

Joseph A. Maurer (1947, 1975), professor emeritus of classics, and chairman pro tem of modern foreign languages and literature. B.A., Moravian, 1932; M.A., Lehigh, 1936; Ph.D., Pennsylvania, 1948.

Gregory T. McAllister, Jr. (1965, 1972), professor of mathematics. B.S., St. Peter's, 1956; Ph.D., Berkeley, 1962.

George E. McCluskey, Jr. (1965, 1976), professor of astronomy. A.B., Pennsylvania, 1960; M.S., 1965; Ph.D., 1965.

Gary E. McConnel (1972), group leader, applications programming, computing center. B.S., Lehigh, 1968.

Charles A. McCoy (1968), professor of government. B.S. Ed., Illinois, 1948; M.A., Colgate, 1950; Ph.D., Boston Univ., 1958.

Steven J. McCulley (1976), Centennial School teacher. B.S., Penn State, 1976.

Joseph B. McFadden (1948, 1961), professor and head of journalism. B.A., St. Joseph's (Canada), 1941; M.A., Syracuse, 1948.

James W. McGeady (1950, 1959), associate director of admission. B.A., Lehigh, 1950.

Edward H. McGee (1970), adjunct professor of law. A.B., Lehigh, 1952; LL.B., Yale, 1955.

Park McGinty (1975), assistant professor of religion studies. B.A., North Carolina, 1965; M.A., Chicago, 1968; Ph.D., 1972.

Anthony J. McHugh (1971, 1976), associate professor of chemical engineering. B.S., Cleveland, 1966; M.S., Delaware, 1970; Ph.D., 1972.

James R. McIntosh (1966, 1973), associate professor of sociology. B.A., Colby, 1960; M.A., Syracuse, 1963; Ph.D., 1969.

James A. McLennan, Jr. (1948, 1968), professor and chairman of physics. A.B., Harvard, 1948; M.S., Lehigh, 1950; Ph.D., 1952.

Judith E. McNally (1972), humanities cataloger, university libraries. B.A., Central Connecticut State, 1968; M.L.S., S.U.N.Y. at Albany, 1972.

John R. McNamara (1973, 1976), associate professor of economics. B.A., Columbia, 1959; M.S., Rensselaer, 1965; Ph.D., 1971.

Charles R. McNaron (1969), head football trainer, and instructor in physical education. B.S., Mississippi State, 1965.

Sarah-Louise Melcher (1974, 1976), administrative assistant to the director of Fritz Engineering Laboratory. B.A., Agnes Scott College, 1973.

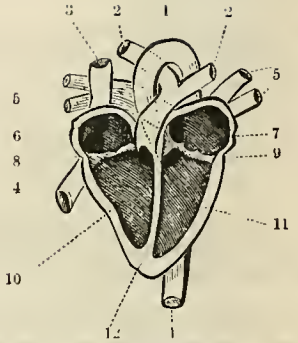


Fig. 201.— THEORETICAL SECTION OF THE HEART.

1. Aorta.
2. Pulmonary artery.
3. Vena cava sup.
4. " inf.
5. Pulmonary veins.
6. Right auricle.
7. Left auricle.
8. Tricuspid valve.
9. Mitral valve.
10. Right ventricle.
11. Left ventricle.
12. Septum.

Norman P. Melchert (1962, 1974), professor of philosophy. B.A., Wartburg, 1955; B.D., Lutheran Theological Seminary, 1958; M.A., Pennsylvania, 1959; Ph.D., 1964.

Joseph R. Merkel (1962, 1965), professor of biochemistry, and director, Marine Biochemistry Laboratory, Center for Marine and Environmental Studies. B.S., Moravian, 1948; M.S., Purdue, 1950; Ph.D., Maryland, 1952.

William F. Meyer (1976), associate trainer, athletics. B.S., Central Connecticut State, 1974; M.S., Trenton State, 1976.

Fortunato J. Micale (1962, 1970), associate professor of chemistry. B.A., St. Bonaventure, 1956; B.S., Niagara, 1959; M.S., Purdue, 1961; Ph.D., Lehigh, 1965.

John A. Mierzwa (1966, 1972), professor of education, and director, division of counselor education, School of Education. B.S., Ohio, 1954; M.A., 1955; Ed.M., Harvard, 1958; Ed.D., 1961.

Jeffrey Milet (1976), assistant professor and head of speech and drama. B.S., Bridgeport, 1963; M.F.A., Yale, 1969.

Larry M. Miley (1967), assistant accountant. B.S., Penn State, 1964.

Paul T. Miller (1961, 1972), superintendent of buildings and grounds.

Paul Van R. Miller (1966, 1973), professor of education. B.A., Yale, 1946; M.A., Pennsylvania, 1948; Ph.D., 1965.

Robert H. Mills (1964, 1976), professor of accounting, and program director of graduate students, College of Business and Economics. B.S., Colorado, 1949; M.S., 1955; Ph.D., Wisconsin, 1960. C.P.A., Illinois, 1957.

Francis J. Minotto (1974), Centennial School teacher. B.S., Lafayette, 1971; M.S., Lehigh, 1973.

Samuel H. Missimer (1950, 1962), director of admission. B.A., Lehigh, 1950.

Judith A. Mistichelli (1974), senior reference librarian, Linderman Library. B.A., Wilkes, 1967; M.S.L.S., Syracuse, 1974.

Joseph C. Mixsell (1974), assistant professor of electrical engineering. B.S., Lehigh, 1967; M.S., Stanford, 1969; Ph.D., Lehigh, 1974.

Sutton Monro (1959, 1964), professor of industrial engineering. B.S., M.I.T., 1942.

Carl L. Moore (1948, 1963), professor and chairman of accounting. A.B., Bucknell, 1943; M.A., Pittsburgh, 1948. C.P.A., Pennsylvania, 1952.

R. Allen Moran (1973), assistant professor of economics. B.A., Columbia, 1965; A.M., Chicago, 1967; Ph.D., Massachusetts, 1971.

Edward P. Morgan (1976), assistant professor of government. B.A., Oberlin, 1968; M.A., Brandeis, 1973; Ph.D., 1975.

John H. Morrison (1968, 1974), operations manager, computing center.

Jamie I. Moyer (1974, 1975), publications assistant, Fritz Engineering Laboratory. B.S., Kutztown, 1972.

R. Charles Moyer (1976), associate professor of finance. B.A., Howard, 1967; M.B.A., Pittsburgh, 1967; Ph.D., 1971.

Rosemary J. Mundhenk (1973), assistant professor of English. B.A., U.S.C., 1967; M.A., U.C.L.A., 1969; C. Phil., 1970; Ph.D., 1972.

Susan W. Murray (1976), Centennial School teacher. B.S., Wisconsin, 1967.

Willard A. Murray (1972), assistant professor of civil engineering. B.S., Wisconsin, 1965; M.S., 1966; Ph.D., 1970.

Paul B. Myers, Jr. (1962, 1965), associate professor of geology. A.B., Colgate, 1955; M.S., Lehigh, 1957; Ph.D., 1960.

N

John W. Nazemetz (1973), instructor of industrial engineering. B.S., Lehigh, 1973.

Debra Nesbitt (1976), admissions counselor. B.A., Moravian, 1975.

William Newman (1968, 1974), associate professor of psychology, director of doctor of arts program, and television coordinator. B.S., C.U.N.Y. (Brooklyn), 1964; Ph.D., Stanford, 1968.

James W. Niemeyer (1968, 1970), executive director, alumni association. B.S., Lehigh, 1943.

Barbara Nothstein (1976), Centennial School teacher. B.S., Indiana Univ. of Pa., 1975.

Michael R. Notis (1967, 1975), associate professor of metallurgy and materials science. B.S., Lehigh, 1960; M.S., 1963; Ph.D., 1969.

Anthony F. Noto (1975), instructor of education. A.B., Lafayette, 1941; M.Ed., Penn State, 1953.

Laszlo K. Nyiri (1977), associate professor of chemical engineering. B.S., Szegad, Hungary, 1949; M.Sc., Kossuth, Hungary, 1955; Ph.D., 1958.

O

John J. O'Connor (1967, 1973), professor of philosophy, Center for Information Science. B.A., Columbia, 1945; M.A., Cornell, 1947; Ph.D., Columbia, 1952.

William E. Ohnesorge (1965, 1971), professor of chemistry. Sc.B., Brown, 1953; Ph.D., M.I.T., 1956.

John Ondria (1967, 1970), associate professor of electrical engineering. B.S., Lehigh, 1960; M.S., 1963; Ph.D., 1967.

Joseph C. Osborn (1946, 1975), professor of mechanics. B.S.M.E., Purdue, 1933; M.S., Michigan, 1946. P.E., Michigan, 1955.

Alexis Ostapenko (1957, 1965), professor of civil engineering. Dipl. Ing., Munich Institute of Technology, 1951; Sc.D., M.I.T., 1957.

Peggy A. Ota (1971), assistant professor of electrical engineering. B.A., Cornell, 1966; M.S., Pennsylvania, 1969; Ph.D., 1972.

Eric V. Ottervik (1966, 1969), vice president for planning. B.S., Carnegie-Mellon, 1959; M.A., Pittsburgh, 1961; Ph.D., 1966.

Kristine J. Ottervik (1972, 1974), operations supervisor, administrative control group.

Jerzy A. Owczarek (1960, 1965), professor of mechanical engineering. Dipl. Ing., Polish Univ. Col. (London), 1950; Ph.D., London, 1954.

P

James Palmer (1976), research associate in chemical engineering. B.S., Brigham Young, 1967; Ph.D., 1974.

Artis J. Palmo (1971), assistant professor of education. B.S., California State (Pa.), 1967; M.A., West Virginia, 1968; Ed.D., 1971.

Robert R. Panos (1964, 1969), assistant director of counseling and testing. B.A., Queen's, 1956; M.S., Penn State, 1958; Ph.D., 1968.

Lloyd C. Parker (1971), Centennial School teacher. B.A., Connecticut, 1956; M.Ed., Lehigh, 1973.

James M. Parks (1967, 1970), professor of geology, and director, Center for Marine and Environmental Studies. A.B., Kansas, 1948; M.S., Wisconsin, 1949; Ph.D., 1951.

Preston Parr (1949, 1970), dean and vice president for student affairs. B.S., Lehigh, 1943; M.S., 1944.

Ruth B. Parr (1967, 1968), Centennial School teacher. B.S., Simmons, 1945; M.A., Lehigh, 1969.

Robert W. Parry (1976), instructor in accounting. B.S., Bloomsburg, 1972; M.B.A., Scranton, 1974.

John W. Paul (1974), instructor in accounting. B.A., Cornell, 1965; M.B.A., Lehigh, 1970. C.P.A., Florida, 1972.

Lawrence M. Paul (1975), assistant professor of psychology. B.S.E.E., Maryland, 1967; M.S.E.E., Illinois, 1969; Ph.D., (psychology) Purdue, 1975.

George Paulli (1976), research associate in chemical engineering. B.S., Michigan, 1961; Ph.D., Indiana, 1968.

Alan W. Pense (1957, 1971), William J. Priestly professor of metallurgy and materials science. B.S., Cornell, 1957; M.S., Lehigh, 1959; Ph.D., 1962.

Joseph A. Petronio (1968), bursar, B.S., King's, 1960.

Robert L. Pettigrew (1969), computing analyst. B.S., Lehigh, 1969.

Heinz G. Pfeiffer (1975), adjunct professor in chemistry. B.A., Drew, 1941; M.A., Syracuse, 1944; Ph.D., California Institute of Technology, 1949.

Robert A. Pfenning (1969, 1974), user services manager, computing center. B.A., Wesleyan, 1962; M.B.A., Michigan, 1964. C.P.A., New York, 1967.

Arthur J. Phelan (1976), professor of military science. B.A., Providence, 1957; M.Ed., Massachusetts, 1976. Lieutenant Colonel, U.S. Army.

Charles R. Phillips, III (1975), assistant professor of classics. B.A., Yale, 1970; B.A., Oxford, 1972; Ph.D., Brown, 1974.

Helene S. Pierce (1976), Centennial School teacher. B.S., East Stroudsburg State, 1975.

Warren A. Pillsbury (1962, 1965), associate professor of economics. A.B., New Hampshire, 1953; M.S., Florida State, 1958; Ph.D., Virginia, 1963.

A. Everett Pitcher (1938, 1960), distinguished professor and chairman of mathematics. A.B., Case-Western Reserve, 1932; A.M., Harvard, 1933; Ph.D., 1935; D.Sc. (Hon.), Case-Western Reserve, 1957.

Louis J. Plebani (1974, 1976), assistant professor of industrial engineering. B.S., Lehigh, 1968; M.S., American, 1972; Ph.D., Lehigh, 1976.

Lucille H. Pleiss (1961, 1971), administrative assistant to director, health service. R.N., St. Luke's Hospital, 1949.

Gary W. Poehlein (1965, 1969), associate professor of chemical engineering. B.S., Purdue, 1958; Ph.D., 1966.

Harold L. Price (1976), assistant football coach. B.S., Lock Haven State, 1958; M.Ed., Slippery Rock State, 1971.

Hayden N. Pritchard (1964, 1970), associate professor of biology. A.B., Princeton, 1955; M.S., Lehigh, 1960; Ph.D., 1963.

Q

William L. Quay (1963, 1970), dean of students. A.B., Muhlenberg, 1956; A.M., Pennsylvania, 1957; Ph.D., Lehigh, 1969.

Clifford S. Queen (1972, 1976), associate professor of mathematics. Ph.D., Ohio State, 1969.

R

Shelden H. Radin (1963, 1974), professor of physics. B.S., Worcester Polytechnic, 1958; M.S., Yale, 1969; Ph.D., 1963.

Harry B. Ramsey (1963, 1971), associate executive director, alumni association, and editor, Lehigh Alumni Bulletin. B.A., Lehigh, 1950.

Viswanatha Raja Gopala Rao (1972), assistant professor of mathematics. B.Sc., Andhra U. (Waltair, India), 1964; M.S., 1965; A.M., Illinois, 1967; Ph.D., 1972.

L. David Raub (1975), senior personnel associate. B.A., Muhlenberg, 1970; M.P.A., Penn State, 1973.

Carol D. Rauch (1968, 1970), librarian, computing center.

Gerhard Rayna (1955, 1969), associate professor of mathematics. A.B., Harvard, 1952; M.A., Princeton, 1953; Ph.D., 1965.

Helen Z. Rayner (1963, 1969), administrative assistant, placement services.

Georgia E. Raynor (1961, 1968), assistant librarian, cataloging. A.B., Chatham, 1945; M.A., Lehigh, 1954; M.S. in L.S., Columbia, 1954.

Richard J. Redd (1958, 1970), professor and chairman of fine arts. B.Ed., Toledo, 1953; M.F.A., Iowa, 1958.

Estoy Reddin (1964, 1967), associate professor of education. B.S., Pennsylvania, 1932; M.S., 1956; Ed.D., 1964.

John K. Redmon (1970), lecturer in electrical engineering. B.S., Newark Col. of Eng., 1942; M.S., Stevens, 1949; M.S., Worcester Polytechnic, 1970. P.E., New Jersey, 1961; Pennsylvania, 1970.

Robert F. Reeves (1968, 1972), assistant dean of students. B.A., Drew, 1966.

Kathryn Reichard (1976), instructor in music. A.B., Wellesley, 1965; A.M., Harvard, 1970.

Robert E. Reidnauer (1961, 1974), programmer/analyst, administrative systems office.

Frederick E. Ressler (1952, 1964), associate registrar. B.A., Lehigh, 1952.

Rodney E. Ressler (1947, 1964), assistant registrar.

Adrian F. Richards (1969), professor of oceanography and ocean engineering and director, Marine Geotechnical Laboratory, Center for Marine and Environmental Studies. B.S., New Mexico, 1951; Ph.D., Scripps Inst. of Oceanography, 1957.

Berry G. Richards (1969, 1976), director of libraries. A.B., Vassar, 1952; M.L.S., New York at Albany, 1969.

Wallace J. Richardson (1952, 1959), professor of industrial engineering. B.S., U.S. Naval, 1941; M.S., Purdue, 1948. P.E., Delaware, 1956.

Martin L. Richter (1965, 1972), associate professor and chairman of psychology.

Mary G. Riley (1953, 1968), head, public service, Linderman Library. B.A., Penn State, 1952; M.S. in L.S., Drexel, 1953.

Alice D. Rinehart (1964, 1974), associate professor of education, and coordinator of educational placement. B.A., Smith, 1947; M.Ed., Lehigh, 1965; Ed.D., 1969.

Donald L. Ritter (1969, 1976), manager, research programs development. B.S., Lehigh, 1961; S.M., M.I.T., 1963; Sc.D., 1966.

Ronald S. Rivlin (1967), Centennial University professor of mathematics and mechanics, and director, Center for the Application of Mathematics. B.A., Cambridge (England), 1937; M.A., 1939; Sc.D., 1952.

Richard Roberts (1964, 1975), professor of mechanical engineering. B.S., Drexel, 1961; M.S., Lehigh, 1962; Ph.D., 1968.

Louis Robinson, Jr. (1974), director, computing associates program, and manager, special projects, computing center. B.E., Johns Hopkins, 1949.

Margetta E. Robinson (1974), administrative assistant, College of Arts and Science. A.A., Utah, 1972.

Donald O. Rockwell, Jr. (1970, 1976), professor of mechanical engineering and mechanics. B.S., Bucknell, 1964; M.S., Lehigh, 1965; Ph.D., 1968.

Robert S. Rogers (1973), assistant professor of chemistry. B.S., M.S., Brooklyn Polytechnic, 1966; Ph.D., Clarkson, 1971.

Robert F. Rosenwein (1972, 1975), associate professor and chairman of social relations. B.A., Berkeley, 1962; M.A., 1963; Ph.D., Michigan, 1970.

H. Joris Rosse (1972), director of physical planning. B.A., Idaho, 1954.

Ann Roth (1977), instructor in speech and drama. B.F.A., Carnegie, 1953.

Christine Roysdon (1974), senior reference librarian, Mart Library. B.A., Arizona, 1970; M.S.L.S., Syracuse, 1974.

Herbert Rubenstein (1967, 1973), professor of philosophy, and adjunct professor of psychology. B.A., Pennsylvania, 1942; M.A., 1943; Ph.D., Columbia, 1949.

J. Donald Ryan (1952, 1962), professor of geology. B.A., Lehigh, 1943; M.S., 1948; Ph.D., Johns Hopkins, 1952.

S

James S. Saeger (1967, 1976), associate professor of history. B.A., Ohio State, 1960; M.A., 1963; Ph.D., 1969.

Eric P. Salathe (1967, 1970), associate professor, Center for the Application of Mathematics. Sc.B., Brown, 1960; M.S., Princeton, 1963; Ph.D., Brown, 1965.

Norman H. Sam (1962, 1970), professor of education, and director, summer session. B.S., Pittsburgh, 1951; M.Ed., 1955; Ed.D., 1962.

Mildred K. Sanders (1973), instructor in English. B.S., S.U.N.Y. at Buffalo, 1960; M.Ed., Lehigh, 1969.

Samson L. Sanders (1973), instructor in physical education, assistant football coach, and assistant track coach. B.S., Buffalo, 1960; M.Ed., 1968.

Jeffrey A. Sands (1973), assistant professor of physics. B.S., Delaware, 1969; M.S., Penn State, 1971; Ph.D., 1973.

Robert G. Sarubbi (1968, 1976), professor of mechanics. B.Sc.E., Cooper Union, 1953; M.S., Lehigh, 1957; Ph.D., 1963.

Kenneth N. Sawyers (1969), assistant professor, Center for the Application of Mathematics. B.S., I.T.T., 1962; Ph.D., Brown, 1967.

Robert J. Schafer (1976), associate professor of aerospace studies. B.A., Evansville, 1962; M.A., Chapman, 1975. Major, USAF.

Stephen W. Schaffer (1973), assistant professor of chemistry. B.S., Buena Vista, 1966; Ph.D., Minnesota, 1970.

Murray Schechter (1963, 1968), associate professor of mathematics. A.B., Brooklyn, 1957; M.A., N.Y.U., 1959; Ph.D., 1964.

William E. Schiesser (1960, 1976), McCann professor of chemical engineering. B.S., Lehigh, 1955; M.A., Princeton, 1958; Ph.D., 1960.

Donald W. Schmoyer (1946, 1962), assistant treasurer. B.S., Lehigh, 1944.

Jeffrey D. Schmoyer (1974, 1975), receiving clerk, university bookstore. A.A.S., Lehigh County Community, 1971.

Keith J. Schray (1972, 1976), associate professor of chemistry. B.S., Portland, 1965; Ph.D., Penn State, 1970.

Priscilla B. Schueck (1974, 1976), data base coordinator. B.A., Moravian, 1973.

Stanley R. Schultz (1966), instructor in physical education, and varsity baseball coach. B.A., Trenton State, 1964.

Eli Schwartz (1954, 1962), professor of economics and finance. B.S., Denver, 1943; M.A., Connecticut, 1948; Ph.D., Brown, 1952.

Thea M. Scioscia (1974, 1975), general book buyer, university bookstore. B.A., East Stroudsburg State, 1973.

Charles Bertram Sclar (1968), professor and chairman of geological sciences. B.S., College of City of N.Y., 1946; M.S., Yale, 1948; Ph.D., 1951.

Eugene R. Seeloff (1973, 1975), director of placement services. B.S., Ball State, 1967; M.A., 1972; Ed.D., 1974.

Barbara E. Seiffert (1974), Centennial School teacher. B.A., Lake Erie, 1969; M.S., Nazareth Col. of Rochester, 1974.

William G. Shade (1966, 1976), professor of history. A.B., Brown, 1961; M.A., 1962; Ph.D., Wayne State, 1966.

Russell A. Shaffer (1964, 1967), associate professor of economics. B.A., Yen-Ching, 1941; M.A., Boston, 1951; Ph.D., North Carolina, 1957.

George K. Shortess (1969), associate professor of psychology. A.B., Lycoming, 1954; M.A., Brown, 1960; Ph.D., 1962.

William J. Sibley (1964), staff psychologist, counseling service. B.S., East Stroudsburg State, 1955; M.Ed., Lehigh, 1964.

John B. Siegfried (1973), adjunct associate professor of psychology. A.B., Rochester, 1960; M.S., Brown, 1962; Ph.D., 1967.

Sharon L. Siegler (1971), head, public services, Mart Library. B.A., Maine, 1969; M.L.S., New York at Albany, 1971.

George C. M. Sih (1958, 1965), professor of mechanics, and director, Institute for Fracture and Solid Mechanics. B.S., Portland, 1953; M.S., New York, 1957; Ph.D., Lehigh, 1960.

Gary W. Simmons (1970, 1974), associate professor of chemistry. B.S., West Virginia, 1961; Ph.D., 1967.

Marvin H. Simmons (1970, 1976), associate director of university publications. B.A., Juniata, 1964; B.F.A. and M.F.A., Yale, 1970.

Roger D. Simon (1970, 1971), assistant professor of history. A.B., Rutgers, 1965; M.A., Wisconsin, 1966; Ph.D., 1971.

Dale R. Simpson (1960, 1966), professor of geology. B.S., Penn State, 1956; M.S., Cal. Tech., 1958; Ph.D., 1960.

Kenneth P. Sinclair (1972), assistant professor of accounting. B.A., Massachusetts, 1968; M.S., 1970; Ph.D., 1972.

John F. Sipics (1976), lecturer in electrical engineering. B.S., Lehigh, 1970.

Zdenek J. Slouka (1972), associate professor of international relations. B.A., Masaryk (Czechoslovakia), 1948; M.A., N.Y.U., 1958; Ph.D., Columbia, 1965.

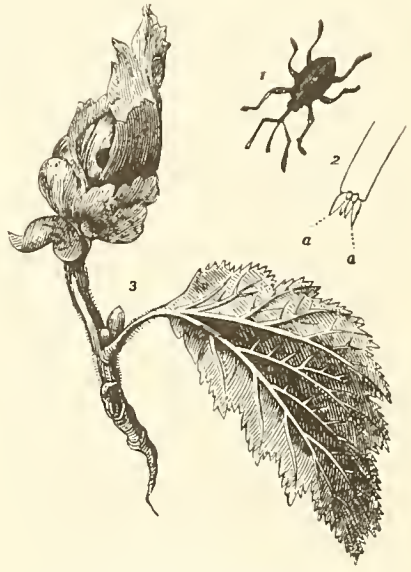


Fig. 270.—1. BALANINUS NUCUM.
2. The tips of the rostrum, magnified, showing the jaws, *a a*
3. Branch of nut-tree, showing the nut bored.

Roger G. Slutter (1961, 1975), professor of civil engineering, and director of operations, Fritz Engineering Laboratory. B.S., Lehigh, 1953; M.S., 1956; Ph.D., 1968.

Bruce M. Smackey (1971), assistant professor of management and marketing. B.S., Rensselaer, 1962; M.S., Case-Western Reserve, 1964; Ph.D., Rensselaer, 1969.

David B. Smith (1972), instructor in economics. B.S., Lehigh, 1969; M.S., 1970; Ph.D., 1972.

Gerald F. Smith (1965), professor, Center for the Application of Mathematics. B.S., Buffalo, 1953; Ph.D., Brown, 1956.

Wesley R. Smith (1958, 1968), professor of physics. B.S., Lehigh, 1950; M.S., 1951; Ph.D., Princeton, 1957.

Oles M. Smolansky (1963, 1970), professor and chairman of international relations. A.B., N.Y.U., 1953; A.M., Columbia, 1955; Ph.D., 1959.

Mervin P. Smolinsky (1970), adjunct professor of psychology. B.A., Temple, 1951; M.S., Pittsburgh, 1966; Ph.D., 1969.

Donald M. Smyth (1971, 1973), director, Materials Research Center, and professor, metallurgy and materials science and chemistry. B.S., Maine, 1951; Ph.D., M.I.T., 1954.

Max D. Snider (1946, 1973), professor of marketing and associate dean of the College of Business and Economics. B.S., Illinois, 1936; M.S., 1937; M.B.A., Stanford, 1941.

Andrew K. Snyder (1967, 1969), associate professor of mathematics. B.A., Swarthmore, 1959; M.A., Colorado, 1961; Ph.D., Lehigh, 1965.

Leslie H. Sperling (1967, 1973), associate professor of chemical engineering. B.S., Florida, 1954; M.A., Duke, 1957; Ph.D., 1959.

Robert S. Sprague (1957, 1966), professor of chemistry. B.S., Washington & Jefferson, 1943; Ph.D., Illinois, 1949.

Richard M. Spriggs (1964, 1972), vice president for administration, and professor, metallurgy and materials science. B.S., Penn State, 1952; M.S., Illinois, 1956; Ph.D., 1958.

Duane E. Stackhouse (1969), associate director, health service. B.S., Juniata, 1957; M.D., Temple, 1961.

William B. Stafford (1967, 1972), associate professor of education. A.B., Ohio, 1954; M.A., 1955; Ed.D., Indiana, 1965.

William E. Stanford (1967, 1970), director of financial aid. B.A., Drew, 1962.

John S. Steckbeck (1962, 1974), associate professor of physical education, and director, intramurals and recreation. B.S., West Chester, 1936; M.Sc., Pennsylvania, 1951.

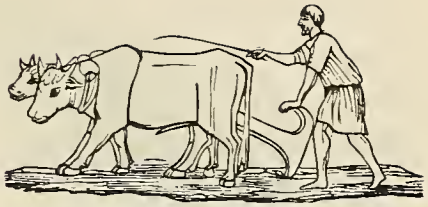


Fig. 57.—THE ROMAN PLOUGH.
(Used in the days of Cincinnatus.)

Fred P. Stein (1963, 1971), professor of chemical engineering. B.S., Lehigh, 1956; M.S.E., Michigan, 1957; Ph.D., 1960.

Olive Stengel (1966), head, circulation service, university libraries.

Gilbert A. Stengle (1960, 1970), professor of mathematics. B.E.P., Cornell, 1954; M.S., Wisconsin, 1957; Ph.D., 1961.

John E. Stevens (1975), assistant professor of management. B.S., Dayton, 1968; M.B.A., 1970; M.A., Cincinnati, 1974; Ph.D., 1975.

Stephen M. Stillman (1973), assistant professor of education. B.S., Pittsburgh, 1966; M.Ed., Teachers, 1968; Ph.D., Ohio State, 1971.

John A. Stoops (1959, 1976), distinguished professor of educational philosophy. B.S., California State, 1948; M.S., Pennsylvania, 1949; Ed.D., 1960.

Robert D. Stout (1939, 1960), professor of metallurgy and materials science, and dean of the graduate school. B.S., Penn State, 1935; M.S., Lehigh, 1941; Ph.D., 1944; D.Sc., Albright, 1967. P.E., Pennsylvania, 1946.

Karol Strelecki (1971), Centennial School teacher. B.S., Rutgers, 1961; M.S., Temple, 1970.

James E. Sturm (1956, 1972), professor of chemistry. B.A., St. John's (Minnesota), 1951; Ph.D., Notre Dame, 1957.

Robert J. Sullivan (1962, 1969), professor of journalism. B.A., Syracuse, 1947; M.A., 1951.

John R. Sumner (1972), assistant professor of geology. B.S., Arizona, 1966; M.S., 1968; Ph.D., Stanford, 1971.

Alfred K. Susskind (1968), professor and chairman of electrical engineering. B.E.E., Brooklyn Polytechnic, 1948; S.M., M.I.T., 1950.

Hugh T. Sutherland (1967), instruments associate, Fritz Engineering Laboratory.

Josephine A. Swartz (1973, 1976), assistant director of undergraduate financial aid. A.B., Catholic, 1964.

T

Donald L. Talhelm (1960), instructor in electrical engineering. B.S., Lehigh, 1959; M.S., 1960.

Lambert Tall (1955, 1970), professor of civil engineering. B.E., Sydney (Australia), 1954; M.S., Lehigh, 1957; Ph.D., 1961.

Barbara J. Tallarico (1973), administrative assistant, special events.

S. Kenneth Tarby (1961, 1973), professor of metallurgy and materials science. B.S., Carnegie-Mellon, 1956; M.S., 1958; Ph.D., 1962.

Robert S. Taylor, Jr. (1950), legal counsel. B.A., Lehigh, 1925; LL.B., Pennsylvania, 1928.

Lamonte L. Tepper (1977), reference librarian, Linderman Library. B.A., Vassar, 1955; M.A., Radcliffe, 1956; M.L.S., Maryland, 1976.

Theodore A. Terry (1951, 1968), associate professor of mechanical engineering. B.S., Drexel, 1950; M.S., Lehigh, 1951; Ph.D., 1963. P.E., Pennsylvania, 1957.

David A. Thomas (1968, 1970), professor of metallurgy and materials science, and associate director, Materials Research Center. B.S., Cornell, 1953; Sc.D., M.I.T., 1958.

David I. Thomas (1975), Centennial School teacher. B.S., Mansfield State, 1975.

James G. Thompson (1976), assistant to the director of intramurals and recreation. B.S., Lehigh, 1974.

Robert J. Thornton (1970, 1974), associate professor of economics. A.B., Xavier, 1965; M.A., Illinois, 1967; Ph.D., 1970.

Ferdinand Thun (1973), adviser, bequests and trusts. B.S., Lehigh, 1956; M.B.A., Harvard, 1960.

James A. Tiefenbrunn (1976), business manager, education, and instructor in accounting. B.S., Lehigh, 1966; M.B.A., 1972.

Charles L. Tipton (1964, 1971), professor of history. B.A., Southern California, 1958; M.A., 1961; Ph.D., 1964.

Jane T. Todd (1974), Centennial School teacher. B.A., Delaware, 1970.

Donald M. Tomasik (1976), assistant professor of military science. B.S., Rutgers, 1967; M.S., Lehigh, 1976. Captain, U.S. Army.

Robert P. Torpey (1976), Centennial School teacher. B.S., East Stroudsburg State, 1973.

Barbara H. Traister (1973), assistant professor of English. B.A., Colby, 1965; M.Phil., Yale, 1968; Ph.D., 1973.

Doris M. Transue (1964), nurse, health service. R.N., St. Luke's Hospital, 1947.

Seymour Traub (1973), assistant professor of law. B.S., N.Y.U., 1961; M.B.A., Lehigh, 1965; J.D., Georgetown, 1969.

L. Reed Tripp (1964), Frank L. Magee professor of business administration. B.A., Union, 1934; Ph.D., Yale, 1942.

Sandralee M. Trippett (1973, 1974), assistant to the bursar. B.A., Lehigh, 1973.

David Trutt (1965, 1971), associate professor of mathematics. B.S., Lafayette, 1959; M.S., Brown, 1962; Ph.D., Purdue, 1964.

John L. Tucker (1975), instructor of finance. B.S. Engr., Maryland, 1967; M.B.A., S.U.N.Y. at Buffalo, 1971.

B. Thayer Turner (1970), assistant professor of physical education, and varsity wrestling coach. B.S., Lehigh, 1961.

Linda L. Turner (1972), admissions counselor. B.A., Dickinson, 1971.

John C. Turoczi (1970, 1973), lecturer in education. A.B., Muhlenberg, 1964; M.Ed., Lehigh, 1967; Ed.D., 1972.

LeRoy J. Tuscher (1971, 1975), associate professor of education. B.S., Northern State, 1958; M.A., Stanford, 1964; Ph.D., Florida State, 1971.

Kenneth K. Tzeng (1969, 1973), associate professor of electrical engineering. B.S., National Taiwan, 1959; M.S., Illinois, 1962; Ph.D., 1969.

U

Dean P. Updike (1965, 1973), associate professor of mechanics. B.S., Princeton, 1957; M.S., N.Y.U., 1960; Ph.D., Brown, 1964.

Paul J. Usinowicz (1972), assistant professor of civil engineering. B.S., Iowa, 1968, M.S., 1969; Ph.D., Michigan, 1972.

V

Victor M. Valenzuela (1957, 1969), professor of Spanish. B.A., San Francisco State, 1951; M.A., Columbia, 1952; Ph.D., 1965.

John W. Vanderhoff (1970, 1974), professor of chemistry, director, National Printing Ink Research Institute, and associate director, Center for Surface and Coatings Research. B.S., Niagara, 1947; Ph.D., Buffalo, 1951.

Anje C. van der Naald (1969, 1973), associate professor of Spanish. B.A., Carleton (Ottawa), 1963; M.A., Illinois, 1965; Ph.D., 1967.

John A. Van Eerde (1960, 1963), professor of romance languages and literature. A.B., Harvard, 1938; M.A., 1939; Ph.D., Johns Hopkins, 1953.

Nan Van Gieson (1973, 1976), assistant provost. B.A., Russell Sage, 1958; M.Ed., Lehigh, 1967; Ed.D., 1969.

David A. Van Horn (1962, 1967), professor and chairman of civil engineering. B.S., Iowa State, 1951; M.S., 1956; Ph.D., 1959. P.E., Iowa, 1957.

Wesley J. VanSciver (1962, 1965), professor of physics. B.S., M.I.T., 1940; Ph.D., Stanford, 1954.

Eric Varley (1967), professor, Center for the Application of Mathematics. B.Sc., Manchester (England), 1955; M.Sc., 1957; Ph.D., Brown, 1961.

Ramamirthan Venkataraman (1968, 1974), associate professor, Center for the Application of Mathematics. B.S., St. Joseph's (Madras, India), 1960; M.A., 1961; Ph.D., Brown, 1968.

Kenneth J. Veprek (1968), technical coordinator—serials, university libraries. B.S., Newark Col. of Engr., 1953; M.S.L.S., Drexel, 1966.

Thomas J. Verbonitz (1967, 1973), director of administrative services. B.S., Lehigh, 1958; M.B.A., 1960.

John F. Vickrey (1961, 1974), professor of English. Ph.B., Chicago, 1949; A.M., 1952; Ph.D., Indiana, 1960.

Ricardo Viera (1974), assistant professor of fine arts, and director of exhibitions. B.F.A., Tufts, 1973; M.F.A., Rhode Island School of Design, 1974.

W

John H. Wachter (1977), systems analyst, administrative systems. B.S., Moravian, 1973.

James H. Wagner (1949, 1951), registrar. B.A., Gettysburg, 1947; M.A., Pennsylvania, 1950.

D. Alexander Waldenrath (1968, 1969), associate professor of German. B.A., Berkeley, 1961; M.A., 1964; Ph.D., 1969.

John E. Walker (1967, 1972), director of computing center, and associate professor of economics. B.S., Clemson, 1958; Ph.D., Virginia, 1963.

Richard M. Walsh (1974), assistant professor of military science. A.B., Seton Hall, 1966; M.A., Lehigh, 1974. Major, U.S. Army.

Elvin G. Warfel (1966, 1971), associate professor of education. B.S., Shippensburg State, 1950; M.Ed., Penn State, 1958; Ed.D., Columbia, 1967.

Roger A. Washburn (1975), Centennial School teacher. B.S., Slippery Rock State, 1973; M.Ed., Shippensburg State, 1976.

George D. Watkins (1975), Sherman Fairchild professor of solid state studies. B.S., Randolph-Macon, 1943; A.M., Harvard, 1947; Ph.D., 1952.

Stuart K. Webster (1972), instructor in accounting. B.A., Heidelberg, 1964; M.B.A., Bowling Green, 1965. C.P.A., Iowa, 1969.

Ben L. Wechsler (1974, 1976), associate professor of industrial engineering. B.S., Carnegie, 1942; M.A., George Washington, 1962; Ph.D., Lehigh, 1974.

Robert P. Wei (1966, 1970), professor of mechanics. B.S., Princeton, 1953; M.S., 1954; Ph.D., 1960.

Daniel J. Weine (1972), social science cataloger. B.A., Vermont, 1961; M.A.T., Harvard, 1962; A.M.L.S., Michigan, 1967.

Richard N. Weisman (1977), assistant professor of civil engineering. B.S., Cornell, 1967; M.S., 1968; Ph.D., 1973.

Leonard A. Wenzel (1951, 1962), professor and chairman of chemical engineering. B.S., Penn State, 1943; M.S., Michigan, 1948; Ph.D., 1950. P.E., Pennsylvania, 1958.

Donald B. Wheeler, Jr. (1947, 1957), associate professor of physics. B.S., Lehigh, 1938; Ph.D., Cal. Tech., 1947.

Howard R. Whitcomb (1967, 1975), associate professor of government. A.B., Brown, 1961; M.A., Lehigh, 1963; Ph.D., S.U.N.Y. at Albany, 1971.

Muriel A. Whitcomb (1975, 1976), assistant dean of students. B.A., Stanford, 1962; M.A., Cornell, 1968.

John C. Whitehead (1967, 1976), instructor in physical education, and varsity football coach. B.S., East Stroudsburg State, 1950.

Walter J. Whitehead (1976), assistant football coach. B.S., Purdue, 1970.

Gary E. Whitehouse (1965, 1974), professor of industrial engineering. B.S., Lehigh, 1960; M.S., 1962; Ph.D., Arizona State, 1966. P.E., Pennsylvania, 1966.

Joseph H. Whritenour (1965), assistant director of public information.

Albert Wilansky (1948, 1957), professor of mathematics. B.A., Dalhousie (Canada), 1941; B.S., 1942; Ph.D., Brown, 1947.

David B. Williams (1976), assistant professor of metallurgy and materials science. B.A., Christ's, Cambridge, 1967; M.A., Cambridge, 1973; Ph.D., 1974.

Robert C. Williamson (1963, 1964), professor of sociology. B.A., U.C.L.A., 1938; M.A., 1940; Ph.D., Southern California, 1951.

John D. Wood (1960, 1965), associate professor of metallurgy and materials science. B.S., Case-Western Reserve, 1953; M.S., Lehigh, 1959; Ph.D., 1962.

Jessica Woods (1977), instructor of speech and drama. B.F.A., Boston Univ., 1963.

Raymond F. Wylie (1973, 1977), assistant professor of international relations. B.A., Toronto, 1964; M.A., 1968; Ph.D., London, 1976.

Y

Diane Yanis (1971), public information associate. B.S., Syracuse, 1970.

W. Ross Yates (1955, 1963), professor of government. B.A., Oregon, 1948; M.A., 1949; Ph.D., Yale, 1956.

Kenneth M. Yeisley, assistant superintendent, buildings and grounds.

Bung-Tseng Yen (1957, 1968), associate professor of civil engineering. B.S., National Taiwan, 1955; M.S., Lehigh, 1959; Ph.D., 1963.

Thomas E. Young (1958, 1966), professor of chemistry. B.S., Lehigh, 1949; M.S., 1950; Ph.D., Illinois, 1952.

Z

Harry T. Zechman, Jr. (1976), assistant professor of education. B.S., East Stroudsburg State, 1963; M.S., Temple, 1968; Ed.D., 1975.

Daniel Zeroka (1967, 1974), associate professor of chemistry. B.S., Wilkes, 1963; Ph.D., Penn, 1966.

Albert C. Zettlemoyer (1941, 1969), provost and vice president, and distinguished professor of chemistry. B.S., Lehigh, 1936; M.S., 1938; Ph.D., M.I.T., 1941; D.Sc., Clarkson, 1965; LL.D., The China Academy, 1974.

Nicholas Zettlemoyer (1972, 1976), assistant professor of civil engineering. B.S., Cornell, 1966; M.S., Penn State, 1968; Ph.D., Lehigh, 1976.

Vincent Ziccardi (1974), assistant professor of aerospace studies. B.S., Rider, 1962; M.B.A., Southwest Texas State, 1974. Captain, U.S.A.F.

Emory W. Zimmers, Jr. (1969, 1976), associate professor of industrial engineering. B.S., Lehigh, 1966; B.S., 1967; M.S., 1967; Ph.D., 1973.

Perry A. Zirkel (June 1, 1977), dean of the School of Education. B.A., S.U.N.Y. at Oswego, 1966; M.A., Connecticut, 1968; Ph.D., 1972; J.D., 1976.

Emeriti

The first year given is the year in which the person commenced employment with Lehigh University. In some cases, individuals left and returned, so that an additional date is given. The final date in all cases is the year in which the person achieved emeritus status.

A

Carl E. Allen (1930, 1964), professor emeritus of accounting. B.S., Illinois, 1923; M.S., 1925; Ph.D., 1930. C.P.A., Pennsylvania, 1939.

Edward D. Amstutz (1938, 1972), Howard S. Bunn distinguished professor emeritus of chemistry. B.S., Wooster, 1930; M.S., Inst. of Paper Chemistry, 1932; Ph.D., Cornell, 1936; D.Sc., Wooster, 1969.

Ray L. Armstrong (1946, 1975), professor emeritus of English. B.A., Williams, 1930; B.A., Oxford, 1932; M.A., 1936; Ph.D., Columbia, 1941.

Lloyd W. Ashby (1966, 1971), professor emeritus of education. A.B., Hastings (Nebraska), 1927; M.A., Columbia Teachers, 1935; Ed.D., 1950.

B

Allen J. Barthold (1939, 1967), professor emeritus of romance languages. B.A., Lehigh, 1921; Ph.D., Yale, 1931.

Jacob L. Beaver (1917, 1952), professor emeritus of electrical engineering. E.E., Lehigh, 1904; M.S., 1921; Sc.D., Harvard, 1932.

Lois R. Benson (191955, 1971), chief nurse administrative assistant emeritus, health service. B.A., Michigan, 1932; R.N., Allentown Hospital, 1939.

Robert D. Billinger (1923, 1965), associate professor emeritus of chemistry. B.S., Lehigh, 1921; M.S., 1925; Ph.D., Cincinnati, 1929.

Charles W. Brennan (1955, 1974), dean of students emeritus and professor emeritus of industrial engineering. B.S., Alabama, 1934; M.B.A., 1953.

Natt B. Burbank (1964, 1971), professor and assistant dean emeritus, school of education. A.B., Vermont, 1925; M.A., Columbia, 1931; LL.D., Vermont, 1963.

Allison Butts (1916, 1957), professor emeritus of metallurgy and materials science. A.B., Princeton, 1911; B.S., M.I.T., 1913.

C

Clarence B. Campbell (1947, 1957, 1974), dean of residence emeritus. B.A., Temple, 1937; M.A., Lehigh, 1947.

Glenn J. Christensen (1939, 1976), university distinguished professor emeritus. B.A., Wooster, 1935; Ph.D., Yale, 1939; LL.D., Col. of Notre Dame (Md.), 1966.

Raymond G. Cowherd (1956, 1975), professor emeritus of history. A.B., William Jewell, 1933; M.A., Pennsylvania, 1936; Ph.D., 1940.

Cloyd Criswell (1947, 1973), professor emeritus of English. B.S., in Ed., Millersville State, 1933; M.A., New York, 1937.

Cassius W. Curtis (1946, 1971), professor emeritus of physics. A.B., Williams, 1928; Ph.D., Princeton, 1936.

Edward H. Cutler (1930, 1968), associate professor emeritus of mathematics. A.B., Harvard, 1925; A.M., 1926; Ph.D., 1930.

D

H. Barrett Davis (1946, 1972), professor emeritus of speech. B.L.I., Emerson, 1929; Cert., American Academy of Dramatic Arts, 1930; M.A. (Hon.), Emerson, 1958.

Warren M. Davis (1971, 1974), lecturer in education. A.B., Ohio, 1933; M.A., Ohio State, 1939; Ph.D., 1952.

Albert W. de Neufville (1948, 1967), associate professor emeritus of mechanics. Dipl. Ing., Berlin, 1922; M.S., Stevens, 1948; Ph.D., Lehigh, 1952.

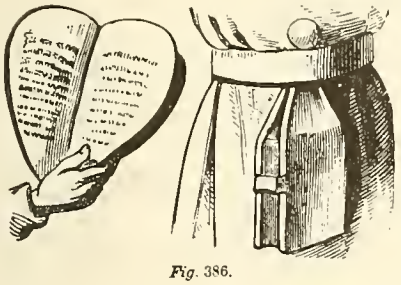


Fig. 386.

Herbert M. Diamond (1927, 1964), professor emeritus of economics. B.A., Yale, 1914; Ph.D., 1917.

Ernest N. Dilworth (1949, 1975), professor emeritus of English. Ph.B., Kenyon, 1933; M.A., Pittsburgh, 1937; Ph.D., Columbia, 1948.

Aurie N. Dunlap (1948, 1973), professor emeritus of international relations. A.B., Union (New York), 1929; A.M., Columbia, 1931; Ph.D., 1955.

E

William J. Eney (1936, 1971), Joseph T. Stuart professor emeritus of civil engineering. B.S., Johns Hopkins, 1927; M.S., Lehigh, 1938. P.E., Pennsylvania, 1939.

James V. Eppes (1950, 1974), professor emeritus of mechanical engineering. B.A., Virginia, 1928; M.E., Cornell, 1931; M.S. in M.E., Lehigh, 1943.

F

George D. Farne (1927, 1966), assistant professor emeritus of romance languages. A.B., Columbia, 1926; M.A., 1927.

Alan S. Foust (1952, 1976), professor emeritus of chemical engineering. B.S., Texas, 1928; M.S., 1930; Ph.D., Michigan, 1938. P.E., Michigan, 1947.

G

Robert T. Gallagher (1942, 1976), professor emeritus of mining engineering; associate dean emeritus, College of Engineering and Physical Sciences. B.S., Penn State, 1927; M.A., Missouri, 1938; D.E.M., Colorado School of Mines, 1941. P.E., Pennsylvania, 1945; New Jersey, 1955.

H

George D. Harmon (1925, 1964), professor emeritus of American history. B.A., Duke, 1921; M.A., 1922; Ph.D., Penn, 1930.

Robert A. Harrier (1951, 1970), executive secretary emeritus, alumni association. E.M., Lehigh, 1927.

Ladd E. Hoover (1960, 1967), associate director emeritus of the university health service. B.Sc., Nebraska, 1924; M.D., 1926.

K

Edwin B. Keim (1973, 1976), associate professor emeritus of education. B.S., West Chester State, 1934; M.S., Pennsylvania, 1940; Ed.D., 1951.

L

Nancy Larrick (1964, 1976), adjunct professor emeritus of education. B.A., Goucher, 1930; M.A., Columbia, 1937; Ed.D., N.Y.U., 1955.

Voris V. Latshaw (1931, 1969), associate professor emeritus of mathematics. B.A., Indiana, 1927; A.M., 1928; Ph.D., 1930.

John D. Leith (1945, 1964, 1966), dean emeritus of students. A.B., North Dakota, 1920; A.M., Columbia, 1924.

M

Ethel M. McCormick (1964, 1969), associate professor emeritus of education. B.S., Northwestern, 1931; M.Ed., Penn State, 1941; D.Sc.Ed., Cedar Crest, 1963.

George W. McCoy, Jr. (1956, 1970), university physician emeritus. B.S., Pennsylvania, 1929; M.D., 1932.

Albert C. Molter (1960, 1974), purchasing agent emeritus. B.S., Norwich, 1928.

N

Harvey A. Neville (1927, 1964), president emeritus. A.B., Randolph-Macon, 1918; M.A., Princeton, 1920; Ph.D., 1921; LL.D. (Hon.), Randolph-Macon, 1952; L.H.D. (Hon.), Moravian, 1962; LL.D. (Hon.), Lafayette, 1962; Sc.D. (Hon.), Lehigh, 1965.

O

Bradford B. Owen (1945, 1974), professor emeritus of biology. B.A., Williams, 1934; M.A., 1936; Ph.D., Harvard, 1940.

P

Basil W. Parker (1940, 1974), professor emeritus of biology. S.B., M.I.T., 1933; A.M., Harvard, 1935; Ph.D., M.I.T., 1939.

Howard C. Pieper (1967, 1973), university physician emeritus. B.S., Iowa State, 1926; M.D., 1932.

R

Edgar H. Riley (1926, 1958), associate professor emeritus of English. A.B., Cornell, 1915; Ph.D., 1925.

S

Raymond B. Sawyer (1946, 1964), associate professor emeritus of physics. Ph.B., Ripon, 1921; M.S., Wisconsin, 1925; Ph.D., Chicago, 1930.

Ernest B. Schulz (1927, 1965), professor emeritus of political science. B.S., Michigan, 1920; M.A., 1921; Ph.D., 1927.

Charles A. Seidle (1948, 1970), vice president emeritus. B.A., Pittsburgh, 1931; M.A., Columbia, 1936; Ed.D., 1948.

Edith A. Seifert (1923, 1969), bursar emeritus.

Jonathan B. Severs (1927, 1969), distinguished professor emeritus of English. A.B., Rutgers, 1925; A.M., Princeton, 1927; Ph.D., Yale, 1935. F.R.S.A., 1962.

Fig. 803. — FLYING DRAGON.
(*Draco fimbriatus.*)

E. Kenneth Smiley (1934, 1964), vice president emeritus. A.B., Bowdoin, 1921; M.A., Lehigh, 1935; L.H.D. (Hon.), Moravian, 1947; LL.D. (Hon.), Waynesburg, 1952.

Judson G. Smull (1919, 1950), associate professor emeritus of chemistry. B.S., Lehigh, 1906; M.S., 1921.

Wilbur D. Bernhart Spatz (1946, 1973), professor emeritus of physics. B.S., Lafayette, 1930; M.S., Purdue, 1934; Ph.D., New York, 1943.

Carl F. Strauch (1934, 1974), distinguished professor emeritus of English. A.B., Muhlenberg, 1930; M.A., Lehigh, 1934; Ph.D., Yale, 1946; D.H.L. (Hon.), Muhlenberg, 1973.

Milton C. Stuart (1926, 1952), professor emeritus of mechanical engineering. B.S., Penn, 1909; M.E., 1924.

T

Merle W. Tate (1965, 1974), professor emeritus of education. A.B., Central Wesleyan, 1926; M.A., Montana, 1943; Ed.M., Harvard, 1946; Ed.D., 1947.

Everett A. Teal (1945, 1975), director emeritus of placement services. B.S., Ball State, 1932; M.A., Columbia, 1941.

Francis J. Trembley (1928, 1972), professor emeritus of ecology. B.S., Hobart, 1928; M.S., Lehigh, 1931; Ph.D., Penn, 1934; D.Sc., Hobart, 1964.

John S. Tremper (1939, 1968), associate professor emeritus of German. A.B., Colgate, 1928; M.A., Cornell, 1932; Ph.D., 1938.

Wendell P. Trumbull (1957, 1974), professor emeritus of accounting. B.S., Illinios, 1937; M.A., Michigan, 1941; Ph.D., 1954. C.P.A., Mississippi, 1949.

V

Ralph N. Van Arnam (1928, 1967), associate professor emeritus of mathematics and astronomy. E.E., Cornell, 1926; M.S., 1927.

W

Lawrence Whitcomb (1930, 1965), associate professor emeritus of geology. Ph.B., Brown, 1922; A.M., Princeton, 1928; Ph.D., 1930.

Ralph C. Wood (1958, 1961), professor emeritus of German. B.A. and B.E., Cincinnati, 1928; M.A., 1930; Ph.D., Cornell, 1933.

Z

Charles K. Zug (1961, 1975), adviser emeritus on bequests, trusts and insurance. B.S. in I.E., Lehigh, 1927; B.S. in E.E., 1927.

In Memoriam

The following members of the faculty died during the past two years.

Rolf K. Adenstadt, associate professor in the Center for the Application of Mathematics, September 18, 1976.

Adelbert Ford, professor emeritus of psychology, April 2, 1976.

Archie Roscoe Miller, professor emeritus of electrical engineering, November 2, 1976.

John H. Pearson, associate professor and head of the division of speech and drama, July 16, 1976.

George Emil Raynor, professor emeritus of mathematics, September 25, 1975.

Joseph Benson Reynolds, professor emeritus of mathematics and theoretical mechanics, December 24, 1975.

John Harms Ubben, professor emeritus of German, July 30, 1975.

REGISTRATION STATISTICS

	spring 1975	summer 1975	fall 1975	spring 1976	summer 1976	fall 1976
undergraduates	3,819	600	4,147	3,932	687	4,238
graduate students	2,121	1,653	2,117	2,082	1,681	1,984
special students	26	5	20	11	2	12
totals	5,966	2,258	6,284	6,025	2,370	6,234

spring, 1975	senior	junior	soph.	fresh.	total
Arts and Science	306	254	297	349	1,206
Arts and Engineering	7	2	4	20	33
Business and Economics	229	255	266	200	950
Chemical Engineering	62	51	44		157
Chemistry	26	10	13		49
Civil Engineering	86	81	79	1	247
Electrical Engineering	70	65	74	1	210
Engineering		2	46	413	461
Engineering Mechanics	1	1	1		3
Engineering Physics	5	1	2		8
Fundamental Science	21	11	10		42
Industrial Engineering	44	39	33		116
Mechanical Engineering	61	75	67		203
Metallurgy and Materials Science	18	9	20		47
total	936	856	956	984	3,819*

*includes 87 in the General College Division

fall, 1975	senior	junior	soph.	fresh.	total
Arts and Science	201	235	321	416	1,173
Arts and Engineering	7	5	14	18	44
Biology	11	23	9		43
Business and Economics	245	310	274	155	984
Chemical Engineering	51	50	75		176
Chemistry	16	21	13		50
Civil Engineering	83	72	111		266
Electrical Engineering	57	86	86	1	230
Engineering		6	38	519	563
Engineering Mechanics	1	2	1		4
Engineering Physics	2	3	5		10
Environmental Science and Resource Management	14	10	6		30
Fundamental Science	12	7	10		29
Geology	8	10	2		20
Industrial Engineering	41	41	50		132
Mechanical Engineering	72	76	81		229
Metallurgy and Materials Science	10	21	13		44
Psychology	5	6	2		13
total	836	984	1,111	1,109	4,147*

*includes 107 in the General College Division

spring, 1976	senior	junior	soph.	fresh.	total
Arts and Science	255	225	253	354	1,087
Arts and Engineering	10	6	4	18	38
Biology	15	19	9		43
Business and Economics	285	270	260	157	972
Chemical Engineering	59	50	65		174
Chemistry	24	19	7		50
Civil Engineering	85	77	90		252
Electrical Engineering	83	68	66	2	219
Engineering	1	4	56	450	511
Engineering Mechanics	2	1	1		4
Engineering Physics	4	3	3		10
Environmental Science and Resource Management	14	11	9		34
Fundamental Science	11	10	7	1	29
Geology	9	10	5		24
Industrial Engineering	47	45	43		135
Mechanical Engineering	73	76	72	1	222
Metallurgy and Materials Science	9	20	12		41
Psychology	6	6	1		13
total	992	920	963	983	3,932*

*includes 74 in the General College Division

fall, 1976	senior	junior	soph.	fresh.	total
Arts and Science	197	227	353	377	1,154
Arts and Engineering	9	2	10	28	49
Biology	29	15	11		55
Business and Economics	281	280	238	180	979
Chemical Engineering	52	74	105		231
Chemistry	20	18	14		52
Civil Engineering	79	94	96		269
Electrical Engineering	78	79	91	2	250
Engineering		2	55	507	564
Engineering Mechanics	1	1	2		4
Engineering Physics	2	3			5
Environmental Science and Resource Management	13	7	7		27
Fundamental Science	7	6	5		18
Geology	10	8	2		20
Industrial Engineering	41	62	28		131
Mechanical Engineering	72	94	115		281
Metallurgy and Materials Science	18	16	23		57
Psychology	5	3	3		11
total	914	991	1,158	1,094	4,238*

*includes 81 in the General College Division

geographical distribution of undergraduate students

All figures are for fall

	1975	1976		1975	1976		1975	1976
Alabama	2	3	North Carolina	5	2	Hong Kong	4	3
Arizona	1	–	Ohio	46	33	Iran	9	6
California	11	13	Oregon	1	–	Ireland	1	–
Colorado	6	7	Pennsylvania	1,852	1,883	Italy	1	–
Connecticut	171	186	Rhode Island	6	6	Japan	–	1
Delaware	23	27	South Carolina	1	–	Kenya	1	–
District of Columbia	13	14	Tennessee	2	2	Korea	1	1
Florida	27	24	Texas	9	8	Kuwait	1	–
Georgia	8	5	Vermont	7	8	Lebanon	5	3
Hawaii	1	–	Virginia	17	18	Liberia	1	1
Illinois	14	16	Washington	2	2	Mexico	1	–
Indiana	3	4	West Virginia	3	2	Netherlands Antilles	2	1
Iowa	1	3	Wisconsin	3	8	Nicaragua	1	1
Kansas	1	–				Norway	1	–
Kentucky	2	1	Algeria	–	1	Panama	3	2
Louisiana	4	2	Belgium	2	2	Peru	1	1
Maine	6	9	Brazil	1	–	Puerto Rico	1	–
Maryland	94	98	Canada	3	2	Spain	1	2
Massachusetts	83	87	Chile	1	–	Sweden	1	1
Michigan	5	12	China	1	1	Switzerland	1	1
Minnesota	3	3	Colombia	2	2	Thailand	1	2
Missouri	5	5	Dominican Republic	–	1	Trinidad	–	1
Montana	1	2	Ecuador	–	3	Turkey	1	1
Nebraska	2	2	France	1	1	United Kingdom	1	–
New Hampshire	4	4	Germany	3	3	Venezuela	–	2
New Jersey	1,044	1,088	Greece	5	3	Virgin Islands	4	2
New York	594	600	Guatemala	1	–			
						totals	4,147	4,238

LATE CHANGES

Business and Economics

The following courses were not included with entries for the departments of accounting and economics.

Acctg 411. Computers and Management (3)
The role of computers in the operation, control, and planning of a business. Uses of computers in recurring operations, problem-solving and decision-making. Basic knowledge of computer hardware and software. System life cycle and the role of managers in system development. Develop a working knowledge of a computer language sufficient to solve business-related problems with batch and interactive processing. This course is designed to meet this background requirement of a student enrolled in the MBA program.

Acctg 415. Financial Flows and Accounting Measurements (3)
A case analysis approach to understanding basic financial accounting theory as a general frame of reference for understanding and evaluating accounting procedures. An introduction to the accounting interpretation with an exposure to controversial issues concerning income determination and asset and equity measurements. Open only to graduate students who have not had a previous course in financial accounting. This course is designed to meet this background requirement of a student enrolled in the MBA program.

Eco 405. Microeconomic Theory (3)
The role of the price mechanism in the allocation of scarce resources among competing uses. Emphasis is placed on the behavior of consumers and firms in various market structures. Attention is given to the pricing of the factors of production, as well as to the analysis of general equilibrium. This course is designed to meet this background requirement of a student enrolled in the MBA program.

Eco 417. Basic Statistics for Business (3)
A first course in statistical analysis dealing with descriptive statistics, probability, and statistical inference in a business context. This course is designed to meet this background requirement of a student enrolled in the MBA program.

Eco 429. Money, Banking and Monetary Policy (3)
An historical overview of money and banking with emphasis on central banking and monetary and fiscal policy. A study of the functions of financial intermediaries, the value of money, the impact of money on income, output, employment and prices. A review of the application of monetary and fiscal policy to deal with economic problems. This course is designed to meet this background requirement of a student enrolled in the MBA program.

FINDING YOUR WAY AROUND

How to reach Lehigh

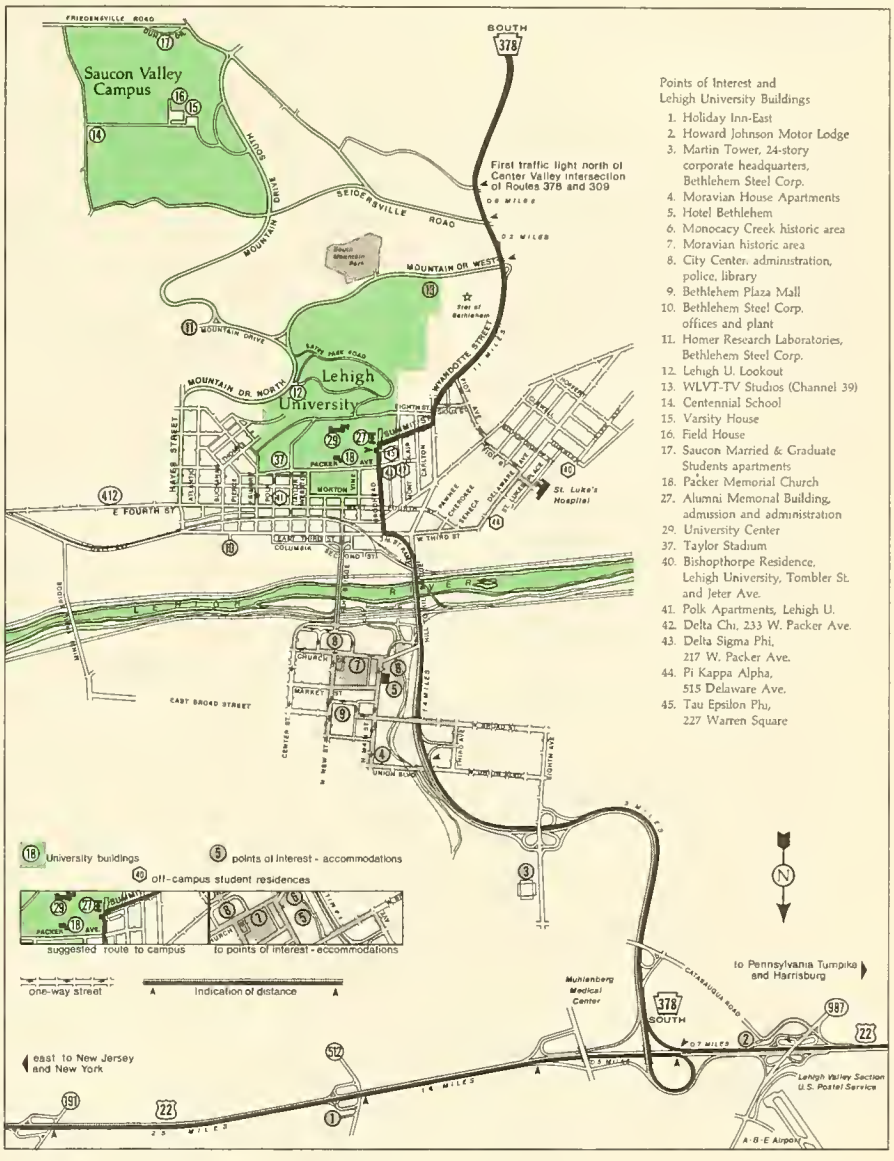
From New York and northern New Jersey. Take Route 22 west and exit at the third Bethlehem exit, Route 378. Continue on 378 south, and as you cross the bridge spanning the Lehigh River, be careful to stay in the left lane. Turn left at the traffic light on the bridge, continue about a block to Brodhead Ave., and turn right. Continue about three blocks until you see the university on your left. Visitors are welcome to park in the lot at Packer and Brodhead Avenues.

From western Pennsylvania. Take Route 22 east, exiting at Route 378, which is the first Bethlehem exit you will see. Continue south as described above.

From Philadelphia and southern New Jersey. Take Route 309 (Bethlehem Pike) north to Center Valley. Turn right onto Route 378 and continue over the first mountain you see. About halfway down the north side of the mountain, turn right onto Summit Street. Continue for about two blocks, to the point where Summit St. ends at Brodhead Ave. The university is directly in front of you. You may continue down Brodhead to Packer Avenue and park in the visitor lot on the northwest corner.

An alternative route for those traveling from southerly points is to take the Northeast Extension of the Pennsylvania Turnpike north and exiting at Exit 32. Then head north towards Quakertown on Route 663 for three and a half miles. Turn left onto Route 309 (West End Boulevard) and continue as described above.

By other means. Buses are available from New York City and Philadelphia. The Reading Company offers several trains to and from Philadelphia and suburbs. Allentown-Bethlehem-Easton Airport, north of Route 22, is served by Allegheny, Altair, United, Eastern and Suburban airlines.



Where to eat

Visitors are welcome in all university dining facilities. Principal facility is the cafeteria-style Cort dining room on the first floor, west, in the University Center. Two adjoining dining rooms are served by the Cort facility. The facility is open all year.

Rathbone Hall dining room is situated on a bluff below the Centennial I residence complex and overlooking the Centennial II buildings. The building is glass-walled and provides an excellent view of the Lehigh Valley. Rathbone is closed during the summer.

These dining facilities provide three daily meals, with three entrees customarily offered for each meal.

The Asa Packer Room, on the third floor of the University Center, is where faculty members dine. It is open only for lunch and only during the academic year. It is the only campus dining facility with waitress service (no tips). Visitors are welcome.

The snack bar on the second floor of the University Center is open all day and late into the evening during the academic year, and during the afternoon in the summer. It is a favorite gathering place for students.

A wide variety of restaurants is available throughout the community.

Campus tours

Prospective students and their families are cordially invited to participate in tours of the campus. Visitors and others who desire tours also are welcome. Contact the office of admission, located in the Alumni Memorial Building, to register for a tour.

Tours are customarily available weekdays from 1 to 4 P.M. and Saturdays from 9 to 11:30 A.M. There are no Saturday tours available during the summer months.

SOUTH MOUNTAIN CAMPUS

The accompanying map shows the university's two-hundred acre South Mountain campus. Please note that south is at the top of the map, reversing the customary practice of cartographers. In general, classroom buildings are located in the lower portion of the campus, with residential facilities and other structures located higher up the mountainside. The Lookout at the easternmost point of Sayre Park (location G-6) affords a dramatic overview of the entire Lehigh Valley.

University buildings

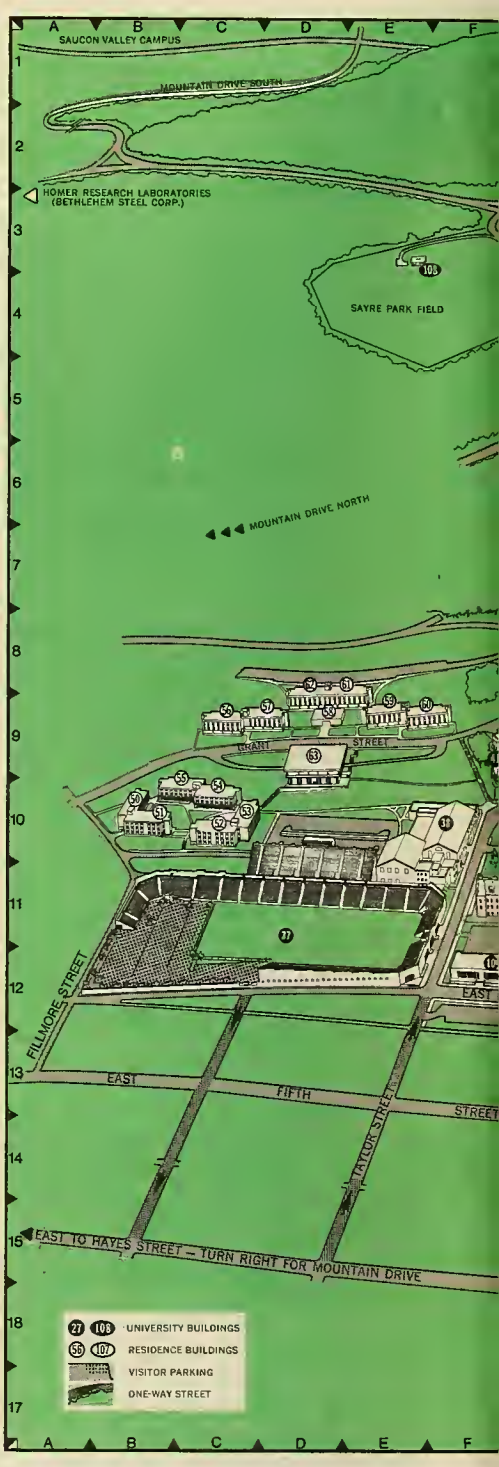
27 Alumni Memorial Building (admission and administration) O-10
192 Audio-Visual Center, 210 Warren Square R-10
9 Bookstore (Maginnes Hall) M-13
3 Buildings and Grounds Office G-12
193 Career Education Building, 222 Summit St. R-10
4 Center for the Application of Mathematics G-12
10 Central Heating and Refrigeration F-12
17 Chandler-Ullmann Hall I-10
6A Chemistry Complex Auditorium J-12
14 Christmas-Saucon Hall J-12
9 College of Arts and Science (Maginnes Hall) M-13
35 College of Business and Economics (Drown Hall) K-8
19 College of Engineering and Physical Sciences (Packard Laboratory) M-11
19 Computing Center (Packard Laboratory) M-11
33 Coppee Hall J-9
32 Coxe Laboratory I-9
35 Drown Hall K-8
23 Education Building and Annex QR-11
2 Figlear Building, Center for the Application of Mathematics L-15
13 Fritz Engineering Laboratory I-11
11 Fritz Laboratory Office Annex H-12
39 Grace Hall G-9
5 Graduate School office (Whitaker) I-13
36 Johnson Hall (health service, counseling service) L-8
34 Lamberton Hall J-8
30 Linderman Library J-9
9 Maginnes Hall M-13
8 Mart Science and Engineering Library K-13
41 Newman Center F-9
19 Packard Laboratory M-11
18 Packer Memorial Church K-11
15 Philosophy Building L-12
16 Physics Building G-11
28 President's House N-9
40 Price Hall G-8
191 Purchasing office, 440 Brodhead Ave. Q-11
63 Rathbone Hall dining facility D-9
Residence Operations, lower level
108 Sayre Park Field and comfort station E-3
26 Sayre Psychology Laboratory P-10
School of Education, 516-524 Brodhead Ave. QR-11
6 Seeley G. Mudd Building IJ-12
1 Service Building (Allied Maintenance Co.) H-16
161 Sherman Fairchild Laboratory for Solid State Studies H-10
7 Sinclair Laboratory J-13
194 Special Education Building, 216 W. Packer Ave. R-11
195 Summer Session Office, 219 Warren Square S-11
38 Taylor Gymnasium F-10
37 Taylor Stadium CDE-11
24 Town House Q-10
29 University Center (Packer Hall) L-9
5 Whitaker Metallurgical and Chemical Engineering Laboratory I-13
12 Wilbur Powerhouse drama facility G-11
31 Williams Hall H-10
Flagpole and University Green L-10
The Lookout (elevation 640 feet) G-6
Reflecting Pool H-11
Sayre Park entrance M-7

Residence halls

55 Beardslee House C-10
Bishopthorpe Residence, Tombler St. and Jeter Ave. (see Bethlehem map)
54 Carothers House C-10
56-62 Centennial I Houses D-8
50-55 Centennial II Houses B-9
58 Commons area D-9
56 Congdon House C-9
65 Dravo House H-7
64 Drinker House I-7
57 Emery House D-9
62 Leavitt House D-8
67 McClintic-Marshall House L-7
61 McConn House E-8
53 Palmer House C-10
71-77 Residence Halls II apartment complex, N-9
66 Richards House G-8
59 Smiley House E-9
52 Stevens House C-10
51 Stoughton House B-10
68 Taylor House M-7
60 Thornburg House E-9
50 Williams House B-10

Fraternity residences

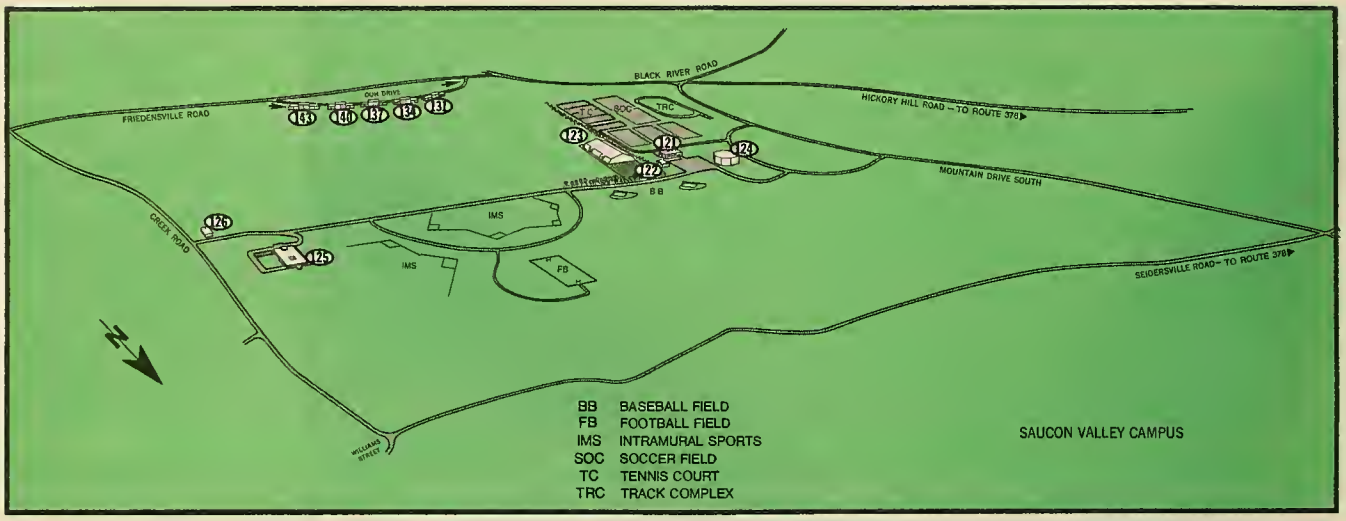
93 Alpha Chi Rho O-4
106 Alpha Sigma Phi N-5
99 Alpha Tau Omega I-5
83 Beta Theta Pi N-6
105 Chi Phi O-5
84 Chi Psi P-6
21 Delta Chi, 233 W. Packer Ave. T-12
22 Delta Chi Annex, 230 W. Packer Ave. S-11
86 Delta Phi R-6
20 Delta Sigma Phi, 217 W. Packer Ave. S-11
89 Delta Tau Delta Q-6
81 Delta Upsilon Q-7
85 Kappa Alpha R-7
87 Kappa Sigma T-5
97 Lambda Chi Alpha L-4
101 Phi Delta Theta L-6
104 Phi Gamma Delta N-6
88 Phi Kappa Theta S-5
90 Phi Sigma Kappa P-5
Pi Kappa Alpha, 515 Delaware Ave.



98 Pi Lambda Phi K-4
80 Psi Upsilon R-8
94 Sigma Alpha Mu Q-3
102 Sigma Chi M-6
82 Sigma Nu O-7
100 Sigma Phi L-7
92 Sigma Phi Epsilon R-5
25 Tau Epsilon Phi, 227-229 Warren Square S-11; annex, 216 Warren Square
91 Theta Chi Q-4
107 Theta Delta Chi K-5
96 Theta Xi M-4
95 Zeta Psi K-4

Sorority residences

Alpha Gamma Delta, Alpha Phi and Gamma Phi Beta are expected to take up residence in the Saucon Valley student apartment complex in the fall of 1977. See Saucon Valley map on the following page for location.



SAUCON VALLEY CAMPUS

Lehigh's Saucon Valley campus, located in the area just to the south of the main South Mountain campus, encompasses four-hundred-and-seventy-eight acres. A wide variety of athletic fields and tennis courts are located in the area. Buildings on the Saucon Valley campus include the following:

124	Athletic and Convocation Center (proposed)
126	Centennial Manual and Fine Arts Annex
125	Centennial School
123	Field House
131-143	Saucon Married and Graduate Students apartment complex (SMAGS)
143	Diamond
140	Gipson
137	Hartman
134	More
131	Severs
122	Squash Court Building
121	Varsity House

The three recently established sororities will take up residence in the Saucon Married and Graduate Students apartment complex in the fall of 1977. The sororities are:

Alpha Gamma Delta sorority
Alpha Phi sorority
Gamma Phi Beta sorority

To reach the Saucon Valley campus, one of three routes may be taken from the South Mountain campus. During the regular academic year (but not during the summer), it is possible to drive into Sayre Park and continue on the road, staying right until the road ends at Mountain Drive. Turn right onto Mountain Drive and bear left at the first fork, just above the Sayre Park playing field. Continue over the mountain and cross Seidersville Road, continuing a short distance until the Saucon Valley campus entrance is seen at left.

For those desiring to reach the Saucon student apartment complex, do not turn left onto the playing fields area. Instead, continue ahead for a short distance to Friedensville Road and turn left. Shortly after a bend to the left, the white brick buildings are visible on the left. Turn onto Duh Drive at the second entrance on the left.

Routes which may be used when Sayre Park is closed to vehicles include the following.

1. Take Summit Street west from the Alumni Memorial Building to its end at Wyandotte Street, Route 378. Turn left and continue up Route 378, turning right onto the jughandle at the first light and continuing left across Route 378 onto Mountain Drive West. Stay to the right, around and over the mountain until the intersection with Seidersville Road is reached. Continue across to the campus entrance at left.

2. Head into South Side Bethlehem to Fourth Street and turn right. Continue a few blocks to Hayes Street and turn right. Continue uphill and pick up Mountain Drive on the right. Bear left at the fork atop the mountain and continue across into the valley, where the campus begins beyond Seidersville Road.

Emergencies and services

Fire. If you are in a university building, sound the alarm to alert others. Then call the Bethlehem fire department, 865-7171 (dial 9 first on university phones to obtain an outside line). Give the name and number of the building, describe the fire, and provide your name. Then tell the campus operator (dial 0 on university phones, 691-7000 on others).

Police. The university police may be reached directly from 8 A.M. to 4:45 P.M. Monday through Friday on extension 2196 or at 691-8032. At other times, phone the Bethlehem police at 865-7171 and request that they send campus police.

Medical assistance. Johnson Hall is the location of the Student Health Service. Persons requiring medical care may visit the service from 8:30 A.M. to noon and 1 to 4 P.M. Monday through Friday, all year. The office is open Saturday from 9:30 A.M. to noon and Sunday from 10 A.M. to noon, but weekend hours are available only during the academic year. If a medical emergency occurs, ring the bell at the upper entrance to Johnson Hall at any time of the day or night, or phone 691-7000, extension 332.

Postal service. The university post office, offering full services, is located on the second floor of the University Center. It is open from 8:15 A.M. to 4:30 P.M. Saturday hours are 8:15 to 11:30 A.M. during the academic year; there are no Saturday hours in the summer.

Bookstore. The university bookstore is located on the ground level of Maginnes Hall. It is usually open from 8 A.M. to 4:30 P.M. It offers sundry items and souvenirs.

Notary service. Members of the campus community have available a free-of-charge notary public service at the student activities desk on the main floor of the University Center.

Recorded messages. The university has available two phone numbers through which specialized information may be obtained. The sports hotline (area code 215) 691-1885, offers latest results of Lehigh's performance in athletics. The student social hotline is (215) 868-8668. These message centers are in operation during the academic year. All calls are at the expense of the caller.

ACADEMIC CALENDAR

1976-77

August 28-30 (Saturday-Monday)
Freshman orientation.
August 30 (Monday)
Undergraduate registration for fall semester.
August 31 (Tuesday)
Fall semester instruction begins.

September 6 (Monday)
First faculty meeting.
September 7 (Tuesday)
Last day for October doctoral candidates to deliver to dean of Graduate School approved dissertation drafts.
September 10 (Friday)
Last day for filing applications for degrees to be conferred on Founder's Day.
September 13 (Monday)
Last day on which registration for fall courses will be permitted.
September 17 (Friday)
Last day for October candidates for master's degrees to deposit with dean of Graduate School unbound copies of theses.
September 24 (Friday)
Last day for October doctoral candidates to complete all degree requirements.
September 27-29 (Monday-Wednesday)
Engineering inspection trips.

October 4-5 (Monday-Tuesday)
Vacation.
October 6 (Thursday)
Monday classes meet.
October 10 (Sunday)
Founder's Day.
October 25 (Monday)
Midsemester reports due.

November 1 (Monday)
Preregistration begins.
November 5 (Friday)
Preregistration ends.
November 24 (Wednesday), 10 P.M.
Thanksgiving vacation begins.
November 29 (Monday), 8:10 A.M.
Thanksgiving vacation ends.
November 29 (Monday)
Last day for January doctoral candidates to deliver to dean of Graduate School approved dissertation drafts.

December 1 (Wednesday)
Last day for filing applications for degrees to be granted in January.
December 11 (Saturday)
Last day of classes.
December 11-14 (Saturday-Tuesday)
Review-Consultation-Study period.
December 15 (Wednesday)
Course examinations begin.
December 17 (Friday)
Last day for January candidates for master's degrees to deposit with the dean of Graduate School unbound copies of theses.
December 23 (Thursday)
Course examinations end.
Last day for January doctoral candidates to complete all degree requirements.

January 10-18 (Monday-Tuesday)
Graduate registration for spring semester.
January 19 (Wednesday)
Undergraduate registration for spring semester.
January 20 (Thursday)
Spring semester instruction begins.

February 2 (Wednesday)
Last day on which registration for spring courses is permitted.

March 1 (Tuesday)
Last day for filing application for degrees in May.
March 12 (Saturday), 1 P.M.
Midterm vacation begins.
March 21 (Monday)
Midsemester reports due.
March 21 (Monday), 8:10 A.M.
Midterm vacation ends.
March 28-April 1 (Monday-Friday)
Preregistration.

April 6 (Wednesday), 10 P.M.
Easter vacation begins.
April 11 (Monday), 8:10 A.M.
Easter vacation ends.
April 15 (Friday)
Last day for May doctoral candidates to deliver approved dissertation draft to dean of Graduate School.

May 6 (Friday)
Last day for May candidates for master's degrees to deposit with dean of Graduate School unbound copies of theses.
Last day for October doctoral candidates to arrange for final examinations.
Last day of classes in spring semester.
May 9-10 (Monday-Tuesday)
Review-Consultation—Study period.
May 11 (Wednesday)
Course examinations begin.
May 13 (Friday)
Last day for May doctoral candidates to complete all requirements.
May 18 (Wednesday)
Course examinations end.
May 29 (Sunday)
University Day.

1977-78

August 22-27 (Monday-Saturday)
Graduate registration.
August 27-28 (Saturday-Sunday)
Freshman orientation.
August 29 (Monday)
Undergraduate registration for fall semester.
August 30 (Tuesday)
Fall semester instruction begins.

September 6 (Tuesday)
Last day for October doctoral candidates to deliver to dean of Graduate School approved dissertation drafts.
September 9 (Friday)
Last day for filing applications for degrees to be conferred on Founder's Day.
September 12 (Monday)
First faculty meeting.
Last day on which registration for fall courses will be permitted.
September 16 (Friday)
Last day for October candidates for master's degrees to deposit with dean of Graduate School unbound copies of theses.
September 23 (Friday)
Last day for October doctoral candidates to complete all degree requirements.
September 26-28 (Monday-Wednesday)
Engineering inspection trips.

October 9 (Sunday)
Founder's Day.
October 11 (Tuesday)
Thursday classes meet.
October 12 (Wednesday)
Friday classes meet.
October 13-14 (Thursday-Saturday)
Vacation.
October 24 (Monday)
Mid-semester reports due.
October 31 (Monday)
Preregistration begins.

November 4 (Friday)
Preregistration ends.
November 23 (Wednesday), 10 P.M.
Thanksgiving vacation begins.
November 28 (Monday), 8:10 A.M.
Thanksgiving vacation ends.
November 28 (Monday)
Last day for January doctoral candidates to deliver to dean of Graduate School approved dissertation drafts.

December 1 (Thursday)
Last day for filing applications for degrees to be granted in January.
December 10 (Saturday)
Last day of classes.
December 12-13 (Monday-Tuesday)
Review-Consultation-Study period.
December 14 (Wednesday)
Course examinations begin.
December 16 (Friday)
Last day for January candidates for master's degrees to deposit with the dean of Graduate School unbound copies of theses.
December 22 (Thursday)
Last day for January doctoral candidates to complete all degree requirements.
December 23 (Friday)
Course examinations end.

January 9-17 (Monday-Tuesday)
Graduate registration for spring semester.
January 18 (Wednesday)
Undergraduate registration for spring semester.
January 19 (Thursday)
Spring semester instruction begins.

February 1 (Wednesday)
Last day on which registration for spring courses is permitted.
February 23-25 (Thursday-Saturday)
Vacation.

March 1 (Wednesday)
Last day for filing application for degrees in May.
March 13 (Monday)
Mid-semester reports due.
March 25 (Saturday), 1 P.M.
Spring vacation begins.

April 3 (Monday), 8:10 A.M.
Spring vacation ends.
April 3-7 (Monday-Friday)
Preregistration.
April 14 (Friday)
Last day for May doctoral candidates to deliver to dean of Graduate School approved dissertation draft.

May 5 (Friday)
Last day for May candidates for master's degrees to deposit with dean of Graduate School unbound copies of theses.
Last day for October doctoral candidates to arrange for final examinations.
Last day of classes in spring semester.
May 8-9 (Monday-Tuesday)
Review-Consultation-Study period.
May 10 (Wednesday)
Course examinations begin.
May 12 (Friday)
Last day for May doctoral candidates to complete all requirements.
May 18 (Thursday)
Course examinations end.
May 28 (Sunday)
University Day.

1978-79

August 21-26 (Monday-Saturday)
Graduate registration.
August 26-27 (Saturday-Sunday)
Freshman orientation.
August 28 (Monday)
Undergraduate registration for fall semester.
August 29 (Tuesday)
Fall semester instruction begins.

September 5 (Tuesday)
Last day for October doctoral candidates to deliver to dean of Graduate School approved dissertation drafts.
September 8 (Friday)
Last day for filing applications for degrees to be conferred on Founder's Day.
September 11 (Monday)
First faculty meeting.
Last day on which registration for fall courses will be permitted.
September 15 (Friday)
Last day for October candidates for master's degrees to deposit with dean of Graduate School unbound copies of theses.
September 22 (Friday)
Last day for October doctoral candidates to complete all degree requirements.

September 25-27 (Monday-Wednesday)
Engineering inspection trips.

October 8 (Sunday)
Founder's Day.
October 17 (Tuesday)
Thursday classes meet.
October 18 (Wednesday)
Friday classes meet.
October 19-21 (Thursday-Saturday)
Vacation.
October 23 (Monday)
Mid-semester reports due.
October 30 (Monday)
Preregistration begins.

November 3 (Friday)
Preregistration ends.
November 22 (Wednesday), 10 P.M.
Thanksgiving vacation begins.
November 27 (Monday), 8:10 A.M.
Thanksgiving vacation ends.
November 27 (Monday)
Last day for January doctoral candidates to deliver to dean of Graduate School approved dissertation drafts.

December 1 (Friday)
Last day for filing applications for degrees to be granted in January.
December 9 (Saturday)
Last day of classes.
December 11-12 (Monday-Tuesday)
Review-Consultation-Study period.
December 13 (Wednesday)
Course examinations begin.
December 15 (Friday)
Last day for January candidates for master's degrees to deposit with the dean of Graduate School unbound copies of theses.
December 22 (Friday)
Last day for January doctoral candidates to complete all degree requirements.
Course examinations end.

January 8-16 (Monday-Tuesday)
Graduate registration for spring semester.
January 17 (Wednesday)
Undergraduate registration for spring semester.
January 18 (Thursday)
Spring semester instruction begins.
January 31 (Wednesday)
Last day on which registration for spring courses is permitted.

February 22-24 (Thursday-Saturday)
Vacation.

March 1 (Thursday)
Last day for filing application for degrees in May.
March 19 (Monday)
Mid-semester reports due.
March 24 (Saturday), 1:10 P.M.
Spring vacation begins.

April 2 (Monday), 8:10 A.M.
Spring vacation ends.
April 2-6 (Monday-Friday)
Preregistration.
April 12 (Thursday)
Last day for May doctoral candidates to deliver to dean of Graduate School approved dissertation draft.

May 4 (Friday)
Last day for May candidates for master's degrees to deposit with dean of Graduate School unbound copies of theses.
Last day for October doctoral candidates to arrange for final examinations.
Last day of classes in spring semester.
May 7-8 (Monday-Tuesday)
Review-Consultation-Study.
May 9 (Wednesday)
Course examinations begin.
May 11 (Friday)
Last day for May doctoral candidates to complete all requirements.
May 17 (Thursday)
Course examinations end.
May 27 (Sunday)
University Day.

Fig. 814.— DIANTHUS HEDEWIGII.

Organizations and honoraries

The university affords its students the opportunity to participate in a wide range of clubs, organizations and honorary organizations. A complete list of active groups is contained in the Student Activities Directory which is produced early in the fall semester. A listing of organizations which were in operation for the 1976-77 academic year follows.

Clubs and societies

Alpha Lambda Omega. This organization is made up of students who commute from the Lehigh Valley area. It is organized as a social fraternity in order to enjoy college social life more fully and to obtain representation on the campus equal to that of other living groups.

Boxing Club. This club meets for practice twice a week. Notices are posted in Taylor Gymnasium regarding details. No experience is necessary. Instruction is given. There are opportunities to compete in the annual intramural tournament as well as other tournaments such as those with other colleges and AAU-sponsored contests.

Bridge Club. The club conducts weekly duplicate bridge tournaments which are open to any member of the faculty or student body. If enough interest is generated, bridge lessons are offered throughout the year.

E. W. Brown Astronomical Society. This club is named in honor of astronomer Ernest W. Brown. In the past the program has included regular monthly meetings with informative films, field trips, and scientific observing sessions. Membership is open to any student who shows an interest in astronomy.

Chess Club. Membership consists primarily of students interested in intercollegiate chess competition. The club is a member of the Eastern Pennsylvania Intercollegiate Chess League which includes Bloomsburg, Dickinson, Franklin and Marshall, Lehigh, Moravian, Muhlenberg, and Shippensburg. However, the club encourages those not interested in intercollegiate competition or of limited experience to attend its weekly meetings. Dues are $2 per semester.

Classics Club. Students in classics are afforded opportunities to meet informally to discuss matters of mutual interest. Membership is open to all undergraduates registered in courses in Greek and Latin and to others interested in classics.

College Young Democrats. The club's objective is to stimulate political awareness on the campus. In the past, it sponsored a debate between the two principal candidates for the Democratic nomination for the U.S. Senate from Pennsylvania. It also sponsored a Lehigh appearance by Governor Shapp. The club is open to all students.

Computer Society. Undergraduate and graduate students who are members become acquainted with new developments in the computing field and receive extracurricular experience in the use of the university's CDC 6400 computer. The society holds regularly scheduled meetings at which computer experts from outside the university speak about their work. Members of the computing center staff also present information concerning the current status of the center's facilities. Membership includes the privilege of using the computer time allotted to the society for the testing and running of computer programs dealing with material not covered under normal academic courses.

Cosmopolitan Club. Originally organized to meet the needs of foreign students, faculty and research assistants, the club provides a means of communication and cultural exchange for students of all nationalities, and brings foreign and American students together through social, cultural and recreational activities.

The club has organized a coffeehouse in The Catacombs, held one night a week, to meet other students, play bridge, chess, backgammon, etc., to discuss a wide variety of subjects, and to listen to music from different countries.

The club intends to organize parties, picnics and excursions. Proposed cultural activities include screening of foreign films, sponsoring lectures, and organizing on international night. Soccer, volleyball and basketball games are planned. There are no fees.

Democratic Club. The organization promotes the principles of the Democratic party on campus. One of the objectives is to encourage Lehigh students to register Democratic and participate in the party. Membership is open to any interested undergraduates, with no dues.

Fencing. Friends and members of the Cut and Thrust Society participate in and seek to promote active fencing at Lehigh. Lessons are given for beginners and weekly fencing sessions are scheduled for those with experience. Each year several competitions are scheduled with other clubs and teams. In addition, many members take part in competitions sanctioned by the Amateur Fencers League of America. Anyone associated with the Lehigh community is invited to contact the society.

Flying Club. This group encourages an interest in the joy of flying among students.

French Club. L'esprit Francais aims to provide French-oriented cultural activities for students and faculty who wish to practice speaking the language. French is spoken at all activities, which include wine and cheese gatherings, movies, lectures, and activities with other French clubs in the area.

Frisbee Club. The goal is to teach the game of Ultimate Frisbee. The club is a team, playing against schools in the southern division of the Frisbee Conference, such as Rutgers and Penn State.

The German Club. Members include students and faculty members interested in the German-speaking countries—literature, travel, etc.—and especially conversation in the language. Meetings are held monthly with the purpose of developing a deeper understanding of the German-speaking world.

German Table. This organization provides, at a weekly dinner, an informal atmosphere in which everyday German can be used. It is intended for students of German, but is also open to any German-speaking members of the Lehigh community.

International Relations Club. The club develops increased interest in international relations through the lectures, films, simulation panels and field trips. Membership is open to all students, with the desire that foreign student input will foster a broader international awareness.

Karate Club. Karate is a highly competitive and demanding sport fought according to carefully defined and strict regulations. It is a valuable tool for improving mental quickness, physical reflexes and coordination. It has undeniable value as a means of self-defense. Instruction in Moo-Duk-Kwan Karate is provided twice weekly by Soon-Ho Chang, 5th Dan Black Belt.

Lehigh Hoopla. The group promotes school spirit through the support of Lehigh's athletic teams. Members have deluged the campus with posters, rallies, pep bands, buttons, and special extravaganzas for games with major rivals. Special emphasis is given to football and basketball seasons.

Lehigh Radio Network. The network offers training in all phases of the radio industry, using equipment and standards concurrent with leaders of the professional broadcasting field. Students interested in music and programming are invited to apply for positions on either of Lehigh's radio stations. WLRN is a top-40 commercial station which broadcasts at 640 AM on campus. Persons who like music from the charts, modified for colleges tastes; who like to communicate with large audiences, and who like a fast-paced show will find WLRN appropriate.

WLVR is Lehigh's progressive rock station which broadcasts at 91.3 FM, and 690 AM on campus. Programming features music from current rock, jazz, soul, and classical albums. Persons with varied musical tastes who like a slower-paced show will fit in at WLVR.

Studios, offices and transmitters are located in the basement of the University Center.

Lehigh Television Network. WLTN provides the campus with student-initiated television programming. Shows range from taped lectures to concerts, from The Dating Game to nightly news. Varsity and intramural sports also are featured. Students are involved in all aspects of the operation: programming, operations, engineering and business. Studio and broadcast

facilities are located in Williams Hall while editing and production facilities are located in Sayre Psychology Laboratory. Interested individuals can phone extension 640.

Lehigh University Grotto. The Grotto, affiliated with the National Speleological Society, presents an active caving program for both experienced and novice cavers. Trips run from short local trips to weekend or longer West Virginia trips, with occasional jaunts into central Pennsylvania and northern New Jersey. For information, contact William Loving, Box F-27.

Lehigh University Society of Hang-Gliders. This organization promotes the sport of foot-launched gliding. It intends to buy, build and fly various types of one-man gliders, and to give recognition to this developing sport.

Lehigh University Outing Club. The group organizes the following activities: back-packing trips, day hikes, rock climbing and canoe trips. Everyone is welcome. Notices of trips are posted in the University Center and Rathbone Hall. For information, write to Box 156.

Men's Volleyball Club. The club encourages and provides practice and competition in the fast-growing sport of power volleyball. The club is a member of the Eastern Collegiate Volleyball League and has scheduled a full season of matches this year.

Model Railroad Club. This group furthers interest in model railroading. Meetings are held weekly to allow an exchange of hobby information and to provide an opportunity for operation of equipment on the club's HO-gauge layout. All equipment is student-owned. Dues are $5 per semester. Membership is open to any student, graduate student or staff member of Lehigh.

Mustard and Cheese. The drama club, founded in 1884 by Richard Harding Davis, is the second oldest such organization in America. Mustard and Cheese works with the division of speech and drama to provide both academic and extracurricular opportunities for those interested in theater. Students work under professional guidance as well as with other students in all phases of drama.

Mustard and Cheese recently moved into the versatile Wilbur Drama Workshop.

Black Students Union. This organization promotes black unity, pride, awareness and culture. The group has its own lounge in the University Center.

Orienteering Club. Orienteering is the only outdoor sport which allows men and women, young and old, to compete equally. It is one of the newest and fastest-growing sports in America.

Originally from Sweden, orienteering is a combination of cross-country racing, hiking, and map-reading. It consists of starting a course at different time intervals and trying to locate certain points in the least amount of time. Since there are different levels of competition with different course lengths, orienteering appeals to everyone, beginner or expert.

Lehigh people compete in about four events a semester with meets held usually on Sundays and occasionally on a Saturday. The Lehigh team and individuals have usually placed well. Everyone is welcome and instruction is always available. The team travels to away meets in Lehigh vans. For information, contact CPT Manns, room 411, Grace Hall (691-7000, extension 2237 or 2238), or Bob Muth, via the university mailroom.

Parnassus. The art society is an organization of students interested in broadening their cultural and intellectual ranges of experience in art and its related fields including photography and motion pictures. Films, lectures, demonstrations and social events are some of the activities available to members. All students are eligible to join, regardless of experience.

Photography Club. The club provides instruction in both the art and science of photography. Lectures instruct members in composition, lighting, darkroom techniques, and other points of interest. New and well-equipped darkroom facilities allow members to put into practice what they have learned. Dues are $10 per semester.

Rugby Club. This sport, the forerunner of American football, is strictly an amateur game, played primarily for the enjoyment of the player. The game is a contest between thirty men fighting for an enlarged pigskin, trying to ground the ball behind the opponent's goal line. Since size is not an important qualification, the club invites all those who have the desire to play to join. Playing in the fall and spring, the club schedules such teams as Rutgers, Temple, Villanova, Penn, Lafayette and Bucknell.

Sailing Club. This organization benefits both the sailor and the would-be sailor. Experienced sailors become part of the university sailing team, which competes seven months of the year in intercollegiate sailing, as a member of the Middle Atlantic Intercollegiate Sailing Association. A number of minor regattas are scheduled each year to permit novice sailors to receive practical experience. Lectures are given by club members. Dues are $3 per semester.

Ski Club. Skiers, whether experts or beginners, are welcome. Highlights include weekly night skiing and ski trips to various ski resorts. The club provides opportunities for intercollegiate competition as well as movies and lectures. Membership fee is $2. Meetings usually are held twice a month during the skiing season.

Student Investment Fund. Student management of the fund's portfolio of common stock provides an opportunity to gain practical stock market experience. Speakers are regularly scheduled on such topics as option trading and investment strategies. The fund encourages an interest in investments, corporate finance, and related topics outside of a classroom situation. Membership is open to all.

Town Council. This organization represents commuting students. There are activities in four areas: social, athletic, scholastic and governmental. Membership is open to all students living in town. Freshmen are especially welcome, as the Town Council helps to integrate the town student into Lehigh life. The council operates the Town Center House at 532 Brodhead Avenue.

University Band. At the beginning of the fall semester auditions are held for the 97, Lehigh's marching band. It is famous for precision drills, full sound and extraordinary spirit.

The Concert Band performs during the spring semester. Concert Band has several performances on and off campus and is open to students upon successful audition.

In addition, several ensemble groups are available for qualified instrumentalists.

University Glee Club. The Glee Club is heard on campus at the annual Parents Day concert in early fall, at Christmas Vespers in December, and at the traditional spring concert. Membership is open by audition any time.

Women's Caucus. Since March of 1974, Lehigh women have had the opportunity to discuss and act upon their needs and interests through the caucus. A seven-member panel plans and directs meetings, which are chaired on a rotating basis by panel members.

The caucus provides mutual support and advocacy for all people interested in the welfare of women associated with Lehigh, bringing together their diverse points of view. Its functions include career counseling, planning social events, providing for friendship and communication among members, and working for specific changes that affect the status and needs of women in the context of the Lehigh community.

During 1975-76, activities included a women's week, participation in the Wednesday afternoon lecture series, and other activities.

Membership is open to any member of the Lehigh community who subscribes to the goals of the Women's Caucus.

Young Republican Club. The club promotes the traditional principles of the Republican Party. It applies these principles in support of various candidates and issues, including those on the Lehigh campus.

Service groups

Alpha Phi Omega. Alpha Psi chapter of APO, a national service fraternity, has a membership of fraternity, residence hall, and town students. Members are interested in serving the campus and community. APO conducts used book sales

and lost and found auctions, ushers at various events, assists local scout troops, conducts a scout visitation day, and shows films. There are scout swim meets, a scout track and field meet, and a few social activities each semester. Membership is open to any student.

Circle K Club. This is a college men's and women's campus action organization sponsored by the Bethlehem Suburban Kiwanis Club. Circle K's purpose is to reach out to the campus and the community and in so doing generate a spirit of harmony and concern that leads to an enrichment of society. The major activities are the annual Lehigh-Lafayette powderpuff football game, an interclub boxing meet, a district rally, volunteer services, and district convention. The Lehigh University Circle K Club is dedicated to unifying people in friendship and involvement.

Civil Air Patrol. Lehigh Senior Squadron 804 was formed in 1972. CAP is a civilian volunteer organization coordinated by the U.S. Air Force, providing almost eighty percent of all search and ground rescue work done in the continental United States. CAP offers free training in many fields, in return for biweekly meetings and service to the community and when disaster strikes. There are opportunities to develop skills and leadership in air operations, ground operations, mechanics, communications, public relations and ground rescue. No military obligation is attached to CAP service, and membership is open to all.

Crossroads Africa. Lehigh is a cooperating institution in the program of Operation Crossroads Africa, Inc., through which North American students devote their summers to work projects in various countries in Africa. The Lehigh committee coordinates fund-raising activities and nominates Lehigh's participants in the program. Students with at least two years of college are preferred. This past summer, Crossroads Africa sent another representative from Lehigh to Africa. In addition, it has started a yearly scholarship fund for a worthy African who participated in the Crossroads project.

Lehigh University Volunteers' Council. LUV Council has become a focal point for the coordination and effective channeling of the energies of an increasing number of people at Lehigh. Having become aware of the potential for interaction between students and the surrounding communities, this student- operated organization has succeeded in establishing diverse programs which involve preschoolers, youth groups, the emotionally disturbed, tutoring and teaching aids, recycling and health services.

The Volunteers' Council seeks students with a variety of interests and recognizes the limitations of a student's schedule. For more information about activities, inquire at the LUV Council office, UC 202.

Course societies

American Institute of Industrial Engineering. The AIIE is an affiliate of the national professional society for industrial engineers. It is open to students in the industrial engineering curriculum or those interested in this field. Activities include monthly meetings with speakers from industry, field trips, regional and national paper competitions, and an annual banquet and faculty student picnic. Membership fee is $7 and includes a subscription to the Industrial Engineering Magazine.

American Institute of Chemical Engineers. This student chapter of the national organization exchanges ideas pertinent to chemical engineering. Membership is open to sophomores, juniors and seniors in the chemical engineering curriculum. Dues are $2. There is no initiation fee.

American Society of Civil Engineers. This student branch of the national society encourages the development of a professional consciousness and affords an opportunity for civil engineering students to become acquainted. Membership is open to any student enrolled in civil engineering. Dues are $6 for sophomores, $7 for juniors and $8 for seniors, with $1 supplements annually. Meetings are held monthly along with regular social functions, such as faculty pub nights. Guest speakers include practicing civil engineers.

American Society of Mechanical Engineers. The student branch of ASME helps engineering students to understand how they will apply their education in industry and to see what type of work a mechanical engineer does after graduation. The society invites engineers from industry to speak at the monthly meetings, and sponsors an annual ASME student papers contest. The society also awards $50 to a member of the junior class for outstanding contributions to the ASME and the mechanical engineering department. Undergraduate membership is open to any registered engineering student. Dues are $5 per year, and include a subscription to Mechanical Engineering magazine.

Arnold Air Society. The society is a national honorary professional organization for Air Force ROTC cadets who desire to develop leadership skills while gaining a fuller knowledge of Air Force organization and traditions. Both service and social aspects are stressed in a program of corps, campus and civic projects. Command and staff position experience is available. There are opportunities for travel and interchange with cadets and officers from other colleges and universities. Meetings are held weekly.

Health Professions Society. The society provides a special opportunity for students who are interested in medical professions and other health-related careers. A 2.5 cumulative average is required for membership.

The society has few meetings but the officers

Fig. 750. — THE PERSIAN CYCLAMEN, (*C. Persicum.*)

Fig. 687. — CORMORANT.

are readily available to answer questions about courses or medical school recommendations.

For a membership application, contact Dean G. Mark Ellis in Maginnes Hall.

Institute of Electrical and Electronics Engineers. The student branch of the IEEE keeps students abreast of recent developments in electrical engineering and helps students decide which aspects of electrical engineering are most interesting to them. The branch brings speakers from the electrical engineering profession to campus and sponsors plant inspection trips and a student papers contest. It also holds a banquet and a picnic. Membership is open to all students interested in electrical engineering and allied sciences.

Marketing Club. This organization gives the student the opportunity to step out of the classroom and participate in actual business activities. The Club welcomes new members and has many activities planned for the '76-'77 school year. The club is open to all students regardless of major. Members pay an initiation fee of $12 by selling four Marketing Club coupon booklets.

Metallurgical Society. This society acquaint the student metallurgist with practical applications and new developments in the field. Meetings are held monthly with guest speakers from industry and research. Membership is available to those interested in metallurgy.

Lehigh Pre-Law Society. The society acquaints students with the opportunities that law provides as a career and provides information to those students who seek assistance in gaining entrance into law school.

Lehigh Ranger Company. This military organization is for Army ROTC cadets. The group plans and conducts its own unit training program, learning through practical work advanced military skills such as mountaineering, communications, patrolling, survival, hand-to-hand combat and first aid, which are not offered in the regular ROTC program. In addition, the group conducts tactical field exercises at Hawk Mountain and Indiantown Gap Military Reservation. The unit meets at 4:15 P.M. Thursdays on the upper floor of Grace Hall.

Lehigh University Drill Team. The team is an organization open to all Army ROTC personnel wishing to further their military knowledge and skills while performing services for the corps of cadets, the university, and the community. The team specializes in basic and trick rifle drill. The drill team competes in collegiate drill competitions and provides the color guard for university functions. For the first time plans are being formulated to work with such local groups as the Boy Scouts. Interested personnel should contact the drill team commander or MAJ R. M. John.

Psi Chi. The Lehigh chapter of the national honorary society for outstanding students of psychology accepts qualified graduate students and undergraduates. The Psi Chi program aims toward a better understanding of the science and profession of psychology. Adviser is Leslie Horst.

Society of American Military Engineers. This club gives students a realistic idea of what different types of engineers do so that they can make a more rational decision as to their future. Three to four club trips to visit industrial firms. are scheduled each semester. The purpose is to provide the members an opportunity to observe engineers on the job, check on projects in various stages of completion, find out about research and development, and see how theory taught at the university is actually applied.

Recent trips have been made to Bethlehem Steel's research laboratories and plant, Western Electric, Mack Trucks, Three-Mile Island Nuclear Power Station, the Berenville Dam, Reading, Pa. and Fort Belvoir, Va., home of the engineers corps. Trips are normally made in the afternoon but occasionally require an entire day.

Society of Physics Students. This organization is designed to provide for the physics student an association with fellow members of the department on an out-of-the-classroom basis. Several lectures are conducted by eminent professionals in the field. These lectures help students obtain a broad perspective of their profession and help them choose a definite field of research. Membership is open to students enrolled in any of the several allied physics and engineering physics curricula.

Student Affiliates of the American Chemical Society. This society encourages student interest in chemistry and the related sciences. The student affiliates meet from time to time to learn about departmental affairs, course changes, and coming events. The affiliates cosponsor speakers with the chemistry department, run the basic seminar series, participate in formulating and reviewing the chemistry curriculum, and run a tutorial program for the basic chemistry courses.

Honorary societies

The university's students have the opportunity to be elected to a large number of honorary societies, including the following.

Alpha Pi Mu, industrial engineering; Beta Alpha Psi, accounting; Chi Epsilon, civil engineering; Delta Sigma Rho-Tau Kappa Alpha, speech; Eta Kappa Nu, electrical engineering; Lambda Mu Sigma, marketing.

Omicron Delta Kappa, leadership; Phi Alpha Theta, history; Phi Beta Kappa, general academic achievement; Phi Eta Sigma, freshman scholastic excellence; Pi Tau Sigma, mechanical engineering; Sigma Xi, graduate research; and Tau Beta Pi, engineering excellence and extracurricular activities.

INDEX

Fig. 1018. — SILVER FIR, (*Abies picea.*)

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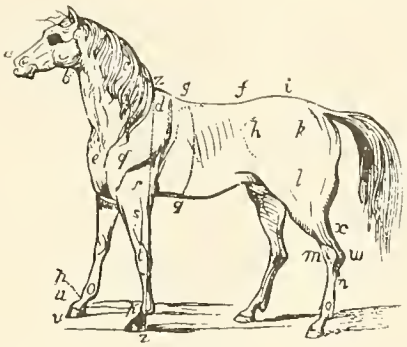

Fig. 1316.

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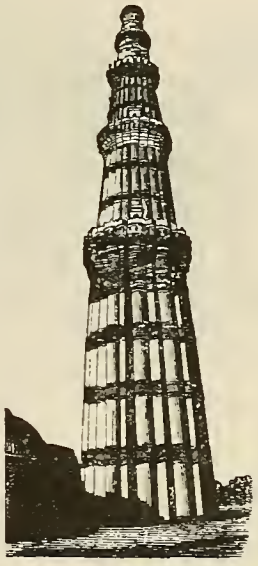

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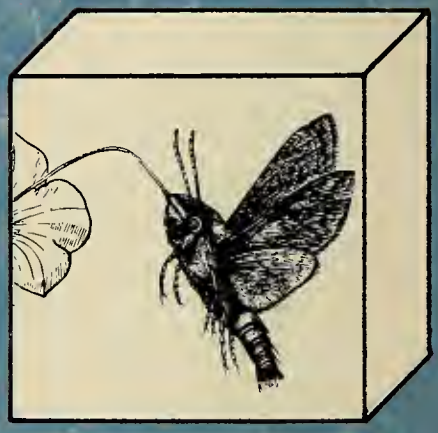

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